A COMPARISON OF INDEXES SUMMARIZING EXPOSURE TO AIRCRAFT NOISE

BY

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EXPOSURE TO AIRCRAFT NOISE

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ABSTRACT

People living around airports are severely impacted by aircraft noise they experience daily, which may damage their hearing, may produce interference with the activities of their daily lives, and may degrade the quality of their life-style.

Noise can be reduced at sources by improved engine technology and by more considerate modes of aircraft operation. Another way of solving the aircraft noise problem is by the use of planning control and here the measurement of noise exposure has an important role to play.

The objective of this study is to test whether any of the noise metrics (the Noise Exposure Forecast (NEF), the Equivalent Sound Level (L_{eq}) and the Day-Night Average Sound Level (L_{dn}))is significantly better as a predictor of the effects of aircraft noise than others. The study used the FAA Integrated Noise Model (INM) to calculate aircraft noise measures. The response data were derived from the social survey conducted for a research of which this thesis is one part.

The study is a necessary step towards standardizing noise measurements. In addition, the study is an aid for airport authorities to assist governments for accurate land use planning.

32. "They said: Glory to Thee:
of knowledge we have none,
save what Thou Hast taught
us: in truth it is Thou
Who art perfect in knowledge
and wisdom"

Sura AL Bagara, THE HOLY QUR'AN

ACKNOWLEDGEMENT

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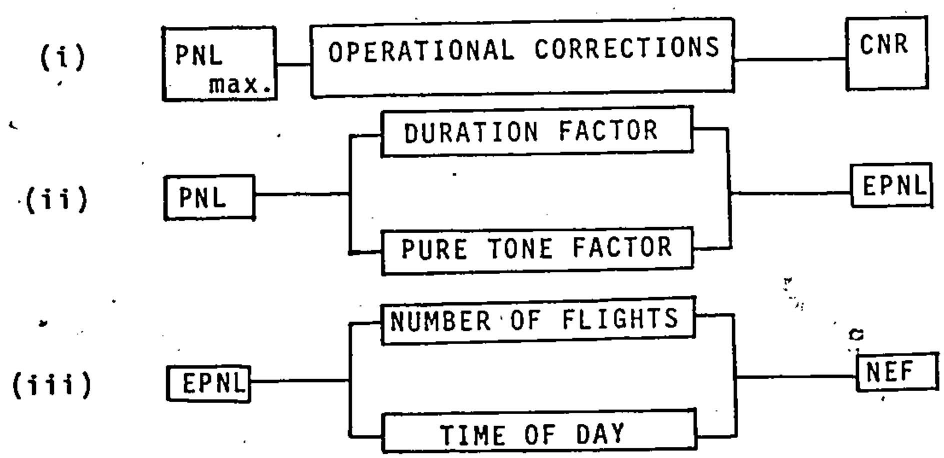
CHAPTER 1

OBJECTIVE AND SCOPE

The purpose of this study is to examine if L_{eq} and L_{dn} measuring approches are as good as the Noise Exposure Forecast (NEF) for aircraft noise measurement. The NEF was developed as an extension and updating of the Composite Noise Rating (CNR) for aircraft noise. The CNR is based on maximum Perceived Noise Level (PNL). The PNL measuring procedure was developed by Rosenblith and Stevens in 1952 (Ref. 1). In response to critics of PNL, Kryter introduced the Effective Perceived Noise Level as a modification of the PNL. The NEF is based on the EPNL (Fig. 1) and was developed for the U.S. Federal Aviation Administration (FAA) in 1967.

Figure 1.1: The Derivation of NEF.



Noise measurements for most other noise sources are based on A-Weighted L_{eq}. The existence of the two different schemes is confusing and hinders understanding of noise.

1.1 Background

People living around airports are severely impacted by the noise they experience daily, which may damage their hearing, may produce interference with the activities in their daily lives, and may degrade the quality of their life-style.

Noise can be reduced at source by improved engine technology and by more considerate modes of aircraft operation. This is one way of trying to reduce the problem of aircraft noise. Another approach is by the use of planning controls and here the measurement of noise exposure has an important role to play, because it can assist the airport authority to:

(i) Use preferential or priority runways (this would maximize use of the runways that produce the least amount of noise over residential areas).

(ii) Develop a rotational runway use system. This would depend on such considerations as time of day, weather, and winds.

(iii) Use preferential flight tracks for landings and takeoffs to avoid noise sensitive areas.

(iv) Limit the operations at the airport during a particular time period or even prohibit operations at certain hours.

1.2 Scope of the Study

The study deals with the following noise metrics:

1. Noise Exposure Forecast (NEF)
2. Equivalent Sound Level (L_{eq})
3. Day-Night Average Sound Level (L_{dn})

Multiple regression and analysis of variance are used to determine the effect of each of the noise levels on selected aggregate responses to aircraft noise for each of the above noise metrics. The objective is to test whether any of the metrics is significantly better as a predictor of the effects of aircraft noise than the others. Four categories of aggregate responses were selected:

1. Percent highly annoyed
2. Percent speech interference
3. Percent complaints
4. Percent sleep interruption

Fifty-six sites around Toronto International Airport were chosen to obtain both interview and physical data. Home interviews were obtained from 673 households. The use of the FAA Integrated Noise Model provided the estimates of aircraft noise exposure in terms of NEF, L_{eq}, L_{dn}, and CNEL for each of the 56 sites.

From the standpoint of community noise standards and regulations, the relationships between noise exposure measurements (NEF, $L_{eq}(24)$, and L_{dn}) and percentile levels of annoyance is important since NEF is the only noise metric used in Canada for aircraft noise by various federal agencies (such as Transport Canada, and Central Mortgage and Housing Corporation).

The study is a necessary step toward standardizing noise measurements. In addition the study is an aid for airport authorities to assist local governments:

(i) to plan and control compatible land use activities near the airport through zoning standards.

(ii) in assessing noise impacts when necessary for environmental impact statements.

(iii) in identification of future noise easement or airport land acquisitions.

CHAPTER 2

NOISE MEASUREMENTS

The appraisal and measurement of aircraft noise differs from other noises, because of: its high level, its contrast to the background noise of the surrounding environment and its duration (up to one minute for both takeoffs and landings).

Previously, measurements of single noise events, by PNL or EPNL, formed the basis for the Composite ~~Noise~~ Rating (CNR) and the Noise Exposure Forecast (NEF) for appraisal and measurements of aircraft noise. Both are discussed in detail further in this chapter. Most current noise measurements are derived from the "energy mean" equivalent of noise levels measured over a specific period, that is L_{eq} metrics. The Day-Night Average Sound Level (L_{dn}) is derived from L_{eq} and both are discussed in detail in this chapter, which explains the fundamentals of noise measurements and several noise metrics. This survey of past and present practices helps to document the need for the comparison which is the focus of this thesis.

2.1 Fundamentals of Noise Measurement

Noise is defined as unwanted sound. Sound is known as acoustic energy and must be characterized by its frequency (Hz), pressure, intensity, and time-pattern. The lowest and the highest frequencies audible to the average adult are about 20 Hz and 10,000 Hz respectively, (Ref. 2). Sound Pressure Level (SPL) is a simple physical measure of sound intensity.

2.1.1 The Decibel (dB)

Sound is measured in decibels. A decibel (dB) is one tenth of a bel and it is 20 times the logarithm to the base 10 of the ratio of the measured root-mean-square (RMS) value of the sound pressure to a reference sound pressure (Ref. 3):

$$dB = 20 \, Log_{10} \frac{P}{P_{ref}} \qquad 2.1$$

where P is the sound pressure in unit per area and P_{ref} is the reference pressure level usually the quietest audible sound considered to be 20 $\mu N/m^2$.

$$20\ \mu N/m^2 = 0.0002 \text{ microbar} = 0.0002 \text{ dyne/cm}^2 \quad 2.2$$

The lowest sound level that a young adult with good hearing can hear represents zero on the decibel scale. Decibels are not linear units, but are logarithmic. Thus 100 dB is equal to 10 billion times as much acoustic energy as one dB.

2.1.2 Weighting Network and Frequency

Response of the human ear varies with both frequency and intensity, which causes difficulties in obtaining direct instrument measurements of perceived noise. The weighting networks modify the frequency response to be similar to the human hearing mechanism. Among the weighting curves (Fig. 2.1) the A-weighting is the one most often used internationally because of its good correlation with people's subjective judgement of annoyance of various types of noise. It is clearly superior to unweighted SPL in predicting people's responses to noise. A-weighted SPL (dBA) is used as a single number rating for aircraft noise, traffic noise levels and industrial noise. The D-weighting network has been developed from noise studies around airports (Fig. 2.2). It has been proposed but not yet adopted by any international standards group.

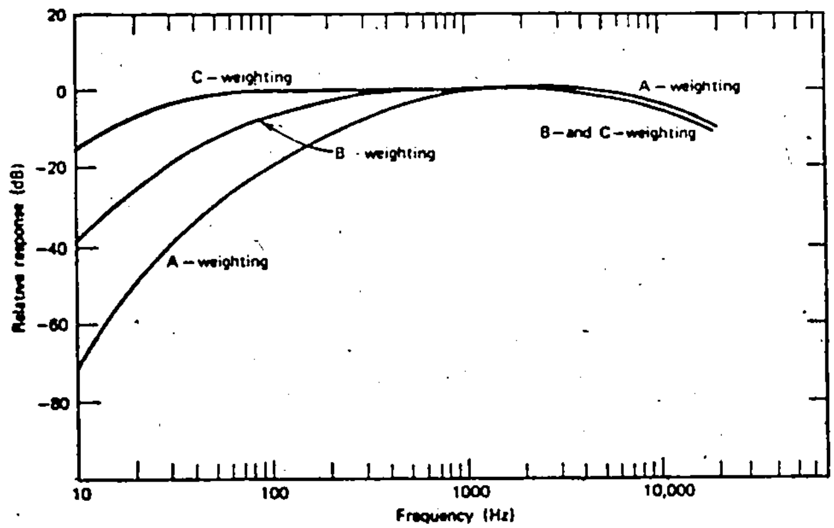


Fig. 2.1 *Relative response of the A-, B-, and C-weighting networks.*

SOURCE: CUNNIFF, P.F., "ENVIRONMENTAL NOISE POLLUTION", 1977

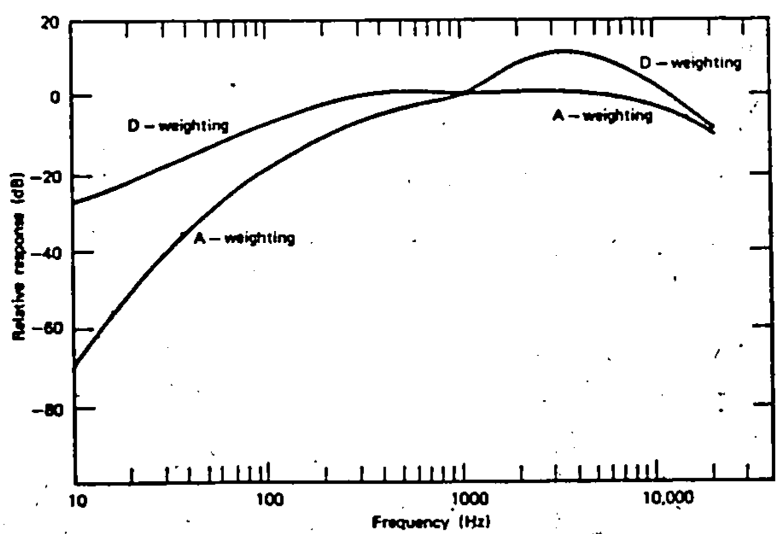


Fig. 2.2 *Relative response of the A- and D-weighting networks.*

SOURCE: CUNNIFF, P.F., "ENVIRONMENTAL NOISE POLLUTION", 1977

A sound level meter which contains an electrical network for A-weighting provides the dBA value. Another way of obtaining dBA is by applying A-weighted values to octave or one-third octave frequency band measures and summing the bands on the basis of their squared pressures.*

2.1.3. Loudness

Towards understanding the problem of noise, engineers and scientists have measured from the threshold of hearing, to the threshold of pain, and have produced a set of equal loudness contours (Fig. 2.3), to correlate with people's judgement of the loudness of sound. These contours have been internationally standardized.

"The numbers on curves are phones, that is, the sound-pressure levels of equally loud 1000-Hz tones, and the levels are plotted according to the centers of bands. To use the contours to obtain the equally loud levels at other frequencies, we find the point on the curve corresponding to the desired frequencies and read off the corresponding sound-pressure level as the ordinate". (Ref. 4)

For example, on the 50-dB contour line a 60-dB level at 100 Hz is just as loud as 50-dB at 1000 Hz tone. This means

* A clearly set-out example of this kind of calculation is found in Reference 8.

that a 60-dB 100-Hz tone is equal in loudness to 50-dB 1000-Hz tone. Therefore, a 100-Hz tone at a sound-pressure level of 60-dB has a loudness level of 50 phones. The equal loudness contours can be used to estimate the loudness level of a simple tone; in addition. Stevens has developed a technique for calculating loudness for steady, wide-band noises. (Ref. 4).

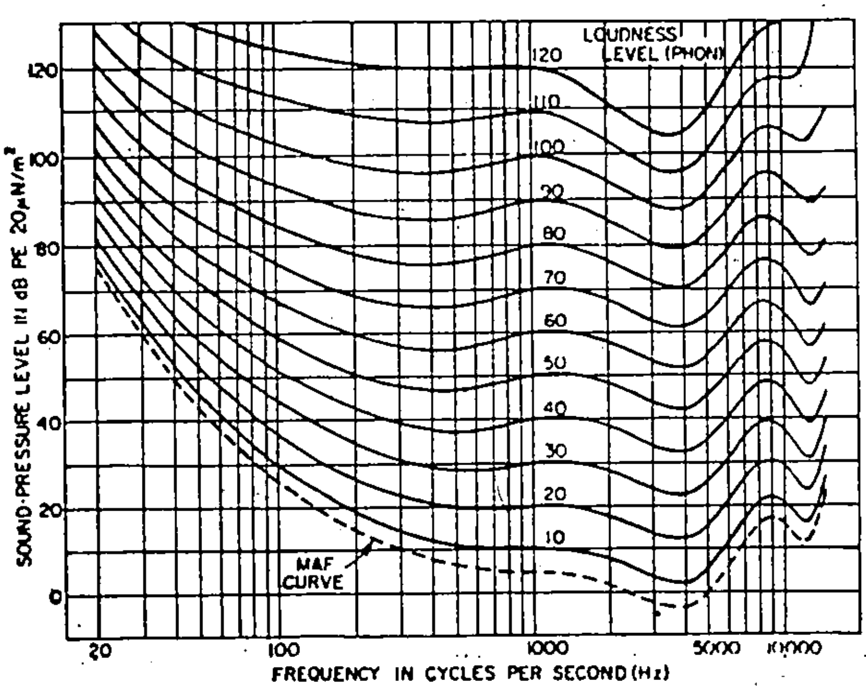


Fig. 2.3: EQUAL LOUDNESS CONTOURS

SOURCE: "HANDBOOK OF NOISE MEASUREMENT"
A.P. Peterson
E.E. Gross, Jr.

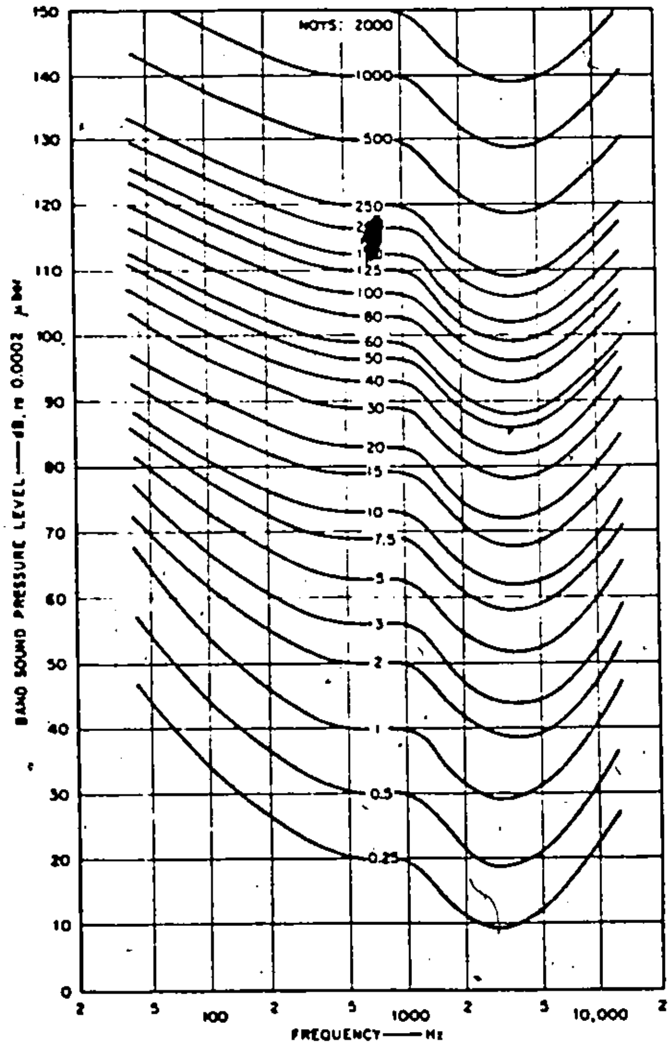


Fig. 2.4: CONTOURS OF PERCEIVED NOISINESS

SOURCE: "THE EFFECT OF NOISE ON MAN"
K.D. Kryter.

2.1.4 Perceived Noise Level (PNL)

Kryter developed the PNL in the early 1950s introducing the first method to measure the annoyance from aircraft noise (Ref. 5). Contours of perceived noisiness shown in Fig. 2.4 resulted from Kryter's and his co-workers investigation and they form the basis for calculation of the PNL.

The calculation procedure for the PNL is as follows:

1. Convert the octave band data to noys using Figure 2.3.
2. Calculate the effective noy value N_t as follows:

$$N_t = 0.3 \sum_i N_i + 0.7\ N_{max} \quad \text{(Octave band data)} \qquad 2.3$$

or

$$N_t = 0.15 \sum_i N_i + 0.85\ N_{max} \quad \text{(1/3 octave band data)} \qquad 2.4$$

where

N_i = noy value for the ith octave band

N_{max} = maximum noy value.

3. Convert the N_t value to PNL in dB using Figure 2.3.

2.1.5 The Effective Perceived Noise Level (EPNL)

The EPNL is a single number measure of the complex noise pattern from an aircraft flyover which approximates laboratory annoyance responses. It is derived from PNL, but it differs from PNL in taking into account both the duration of an aircraft flyover and the presence of audible pure tones or discrete frequencies (such as the whine of a jet aircraft) in the noise signals.

The following shows the calculation of EPNL expressed in EPNdB:

$$EPNL = PNL_{max} + 10 \text{ Log } (\frac{\Delta t}{20}) + F \quad , \quad EPNdB \qquad 2.5$$

in which

PNL_{max} is the maximum perceived noise level during a flyover of a single aircraft.

Δt is the time interval in seconds during which the noise level is within 10 PNdB of the maximum PNL. Figure 2.5 shows graphically how Δt is obtained.

F is the correction for the presence of discrete frequency components (usually about 3dB).

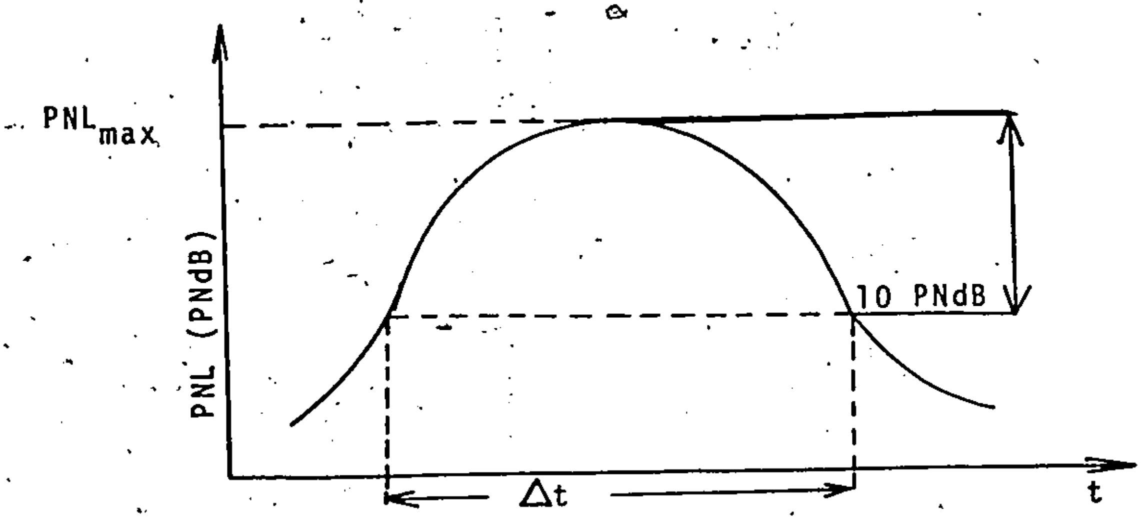


Figure 2.5: THE MEASURED 10 dB DOWNTIME Δt.

Source: "Environmental Noise Pollution"

Cunniff, P.F.

2.1.6 The Composite Noise Rating (CNR)

The CNR is a measure for aircraft noise which uses the maximum value of the PNL with appropriate corrections for frequency of operations and time of day. Early in the 1950s the CNR was introduced in the U.S.A to determine the relative impact of aircraft noise near an airport. It is employed as a guide to land use planning in areas adjacent to airports.

The CNR for a single class of operation j is:

$$CNR_j = PNL_j + 10 \text{ Log } (N_{Dj} + 20\ N_{Nj}) - 12 \qquad 2.6$$

where

N_{Dj} and N_{Nj} are the number of occurrences during day and night respectively.

The total exposure at the site results from the operation of various types of aircraft on different paths, given by the energy sum of the CNR_j.

$$CNR = 10 \text{ Log} \sum_j \text{antilog } (CNR_j/10). \qquad 2.7$$

The early studies developed a correspondence between community reaction and CNR shown in the table below. (Ref. 6):

CNR	OBSERVED ACTION
≤ 105	NO COMPLAINTS
105 - 110	FEW COMPLAINTS
110 - 115	MANY COMPLAINTS, POSSIBLE ACTION
≥ 115	REPEATED COMPLAINTS, ACTION

TABLE 2.1: COMMUNITY REACTION AND CNR

2.1.7 The Noise Exposure Forecast (NEF)

Noise Exposure Forecast (NEF) is the total summation (on an energy basis) over a 24-hour period (weighted for the time of day) of Effective Perceived Noise Level (EPNL) minus the constant 88 dB. The introduction of the NEF came as an up-dating of the CNR, to determine the relative noise impact of aircraft noise in the vicinity of an airport. It is employed as a guide to land use planning for areas near airports and to estimate the effect of various aircraft types and operations on the community. The calculation of the NEF is as follows:

$$NEF = 10 \, Log \left(\sum_{i} \sum_{j} 10^{NEF_{ij}/10} \right) \tag{2.8}$$

in which

$$NEF_{ij} = EPNL_{ij} + 10 \, Log \left(N_{Dij} + 16.67 \left(N_{Nij} \right) \right) - 88 \tag{2.9}$$

i = class of aircraft

j = flight path

N_{Dij} = number of daytime flights of aircraft - i using flight path j.

N_{Nij} = number of nighttime flights of aircraft - i, using flight path j.

The subtraction of a constant (88) is made to avoid confusion with other noise metrics.

2.1.8 Equivalent Sound Level (L_{eq})

L_{eq} is the average (i.e. the average on an energy basis) noise level (usually A-weighted level) integrated over some specified period of time (Ref. 6).

The purpose of L_{eq} is to provide a single number measure of time - varying noise for a predetermined time period. There are two methods to determine the L_{eq}:

1. Continuous Integration.

   For continuous time integration of A-weighted sound level for specified time period, the formula is:

$$L_{eq} = 10 \text{ Log } \frac{1}{T} \left[\int_0^T \text{antilog } (AL\,(t)/10)\; dt \right] \qquad 2.10$$

   in which

   AL (t) is instantaneous A-weighted level at time t.

   T is the specified time period over which the time integration process takes place.

2. Temporal Sampling.

   For discrete sampling of A-weighted sound level for specified time period, the formula is:

$$L_{eq} = 10 \text{ Log} \frac{\sum_{i=1}^{n} \text{antilog } (AL_i/10)}{n} \qquad 2.11$$

in which

AL_i is the instantaneous A-weighted level for sample i

n is the number of samples of AL in a specific time period.

2.1.9 Day-Night Average Sound Level (L_{dn})

L_{dn} is the average (i.e. on an energy basis) A-weighted noise level integrated over a 24-hour period. Appropriate weightings are applied for the noise levels occurring in the daytime and nighttime periods.

The purpose of L_{dn} is to provide a single number measure of time-varying noise for a specified time period. It was designed to improve upon Equivalent Sound Level (L_{eq}) by applying a correction for nighttime noise intrusions. A 10 dB penalty is added to nighttime (2200- 0659) sound levels to account for the increased annoyance at noise during the night hours. L_{dn} uses the same energy equivalent concept as L_{eq}, which is defined as representing a fluctuating noise level in terms of a steady state noise having the same energy content. The U.S. Environmental Protection Agency (EPA) has adopted the L_{dn} as the rating method to describe long-term annoyance from environmental noise. (Ref. 7).

2.2 SUMMARY

Much of the research in psychoacoustics has been undertaken using PNL, EPNL, and dBA. Critics said that PNL adds very little to dBA. Therefore further investigation modified PNL to the EPNL (CNR to NEF). The NEF takes more accurate account of discrete frequency components which are typical of the sound from the more recent turbo-fan jets and adds as well a correction factor for the duration of the sound. The CNR does not consider either the duration factor nor the pure tone factor. It is clear from previous sections, that the calculation procedure for the NEF is more complicated than the CNR calculation (Ref. 11).

L_{eq} is simpler to obtain than NEF. It is used for numerous other sources, but has never been used to evaluate aircraft noise impact on the community residing around an airport.

This study tests whether NEF has any advantages over L_{eq} or L_{dn} for appraising aircraft noise impact.

CHAPTER 3

ORGANIZATION OF THE REQUIRED INPUT DATA FOR CALCULATION OF NOISE MEASURES

This chapter explains how the data is organized to run the FAA Integrated Noise Model (INM). The INM is a computer program which predicts the noise of aircraft in the vicinity of an airport in terms of Noise Exposure Forecast (NEF), 24-hour Equivalent Sound Level (L_{eq}), Day-Night Average Sound Level (L_{dn}) and Community Noise Equivalent Level (CNEL) for selected points on the ground (a grid analysis for specific coordinates around an airport) or in terms of contours of equal noise exposure.

The INM is widely used in U.S.A. and copies of the program have already been sent to several other countries. The FAA in March 1976 introduced the INM with only L_{dn} and time of exposure above a threshold of A-weighted sound level (TA) noise metrics. In January 1978 the INM Version 1 was introduced which provides the user with all the above mentioned noise metrics with one computer program and requires the preparation of the input data only once. In fact, it is the flexibility in output that makes the INM very useful. In addition, another significant feature of the INM is the data base stored in the program which contains the noise and performance data for a number of common civil aircraft, eliminating the necessity to determine and enter other parameters. The INM provides the three noise metrics (NEF, L_{eq} and L_{dn}) being dealt with in this study. This chapter illustrates the organization of the required input data for the INM. First an X-Y coordinate system was defined, then the ground tracks used by the aircraft, and traffic mix were identified. Further, the landing profile was defined, and the traffic mix was identified to complete the required input data.

3.1 Coordinate System and Runways

An X, Y co-ordinate system was defined to identify the locations of the runways and of each one of the 56 sites at which the noise calculations are to be made (see Fig.3.1). Each runway is described by 2 points. Each point consists of the location of the brake release point for takeoffs in the opposite directions. Thus, there are 6 runways.

3.2 Ground Tracks

Ground tracks are projections along the ground of the aircraft's flight paths (see Fig. 3.2). There are 30 tracks for the runways of Toronto International Airport. Each runway has 5 tracks, 4 of them for takeoffs having right

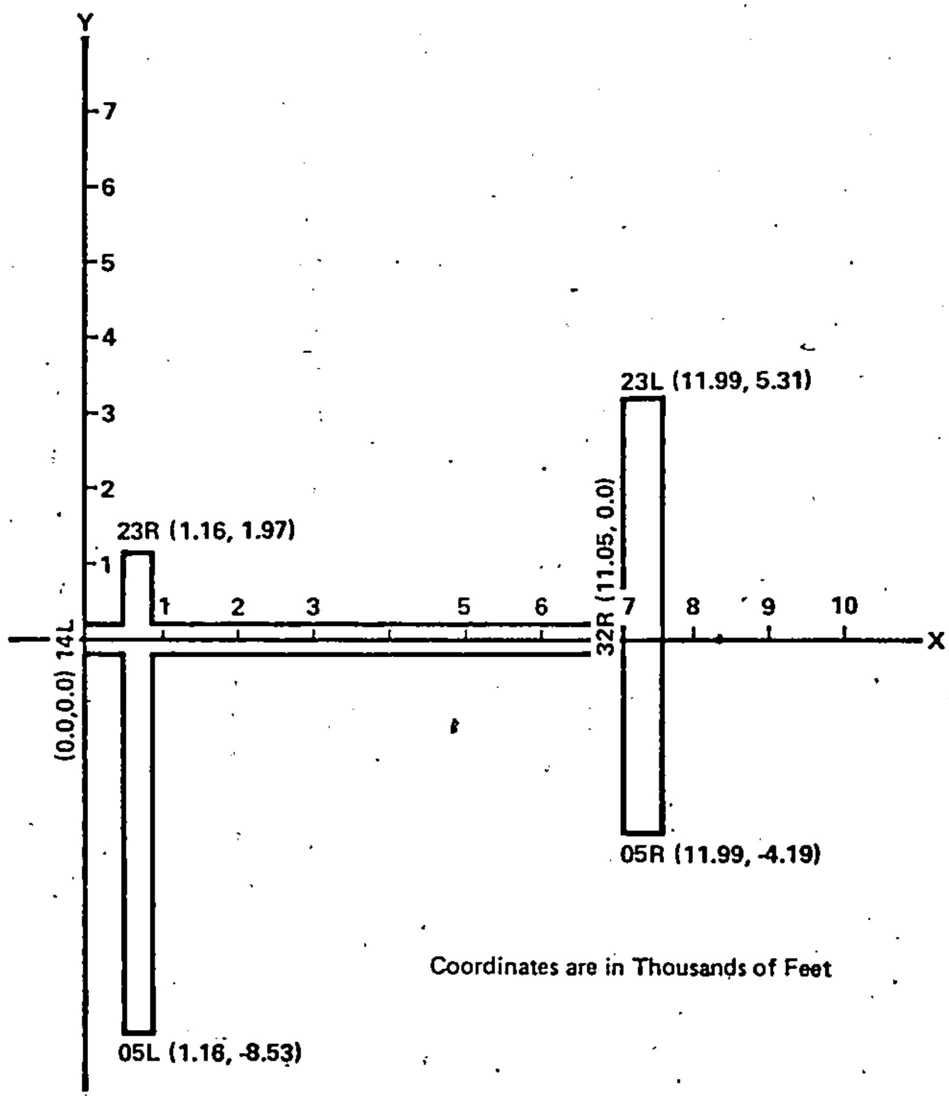


Figure 3.1: Coordinate System for Toronto International Airport

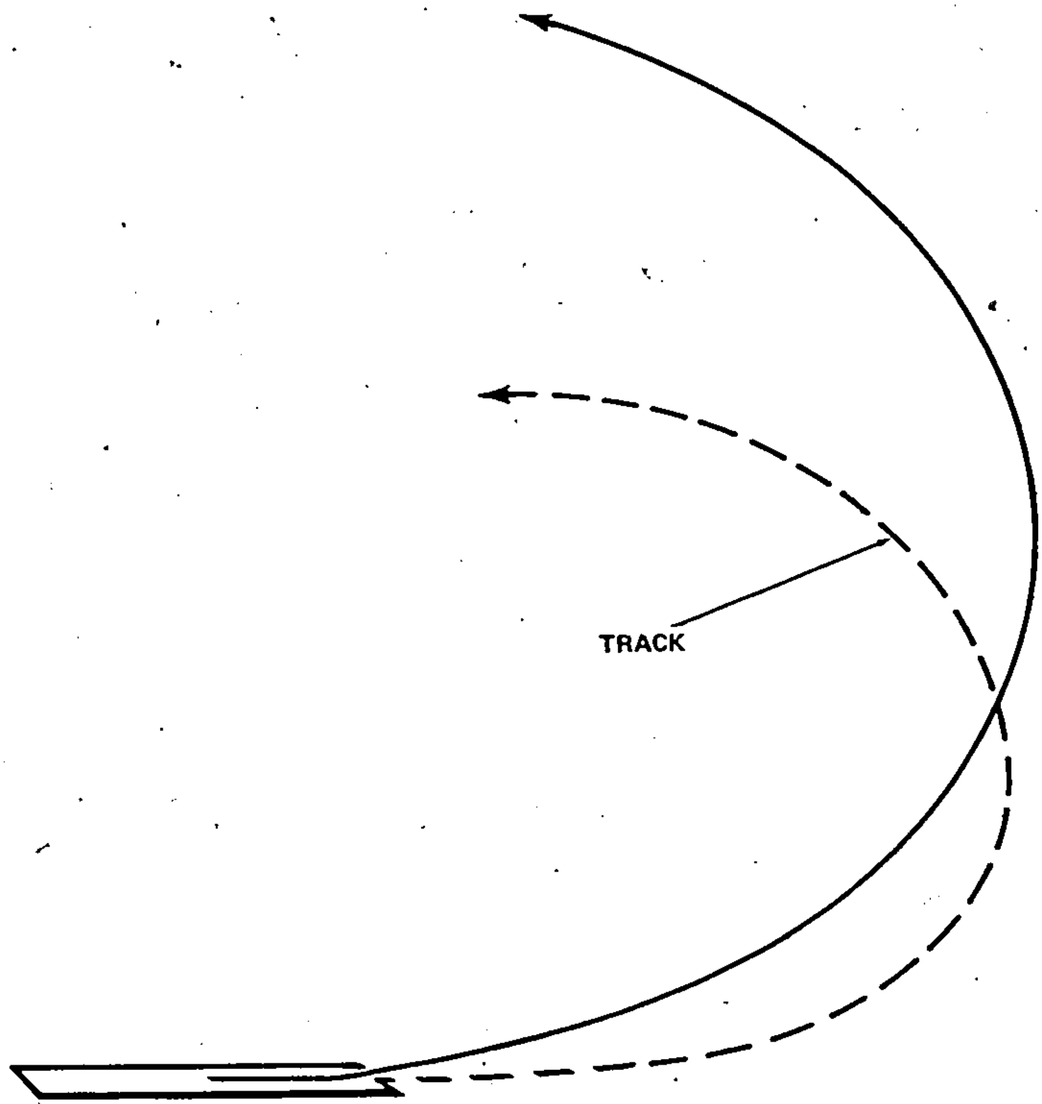


Figure 3.2: Flight Path

or left turns, and the remaining one a straight track for landings. Each track consists of three segments. The first segment is the distance from the threshold of the runway to the outer marker where aircraft initiate their turns. The second segment is the turn angle (the angle between the third segment and the centre line of the runway), and the turn radius which is equal to 2.3 n.mi. The third segment is a straight line 50 n.mi. long.

The turn radius is calculated as follows:

An aircraft's rate of turn depends on its velocity and amount of bank. The equation for finding the angle of bank is:

$$\text{Tan } \phi = \frac{2 \pi V}{gt} \qquad 3.1$$

Where ϕ = Angle of bank

π = 3.1416

V = Velocity of the aircraft

g = Acceleration of gravity (32.2 feet/second^2)

t = Time in seconds required for a 360 degree turn (in this case a standard rate turn will be 120 seconds).

$$\text{Turn Radius} = \frac{\text{Velocity}^2 \text{ (in feet/sec.)}}{g \times \text{Tan } \phi} \qquad 3.2$$

For the present study -

$$V = 175 \text{ mph}$$

$$\emptyset = 8^o$$

$$V = 175 \times 1.467 = 256 \text{ feet/second}$$

$$\text{Tan } \emptyset = 0.14054$$

$$TR = \frac{(256)^2}{32.2 \times 0.14054} = 14481 \text{ feet}$$

$$= \underline{\underline{2.3 \text{ N.M.}}}$$

A negative sign for the turn radius means that it is a left turn track and a positive turn radius signifies a right turn track. For convenience, track 1, 2, 6 and 10 are reprinted in Fig. 3.3. There are 6 straight tracks with only one segment each. These tracks are considered as landing tracks.

Figure 3.4 illustrates all the tracks for the runways of Toronto International Airport and Tables 3.1, 3.2 and 3.4 provide the segments of each runway track.

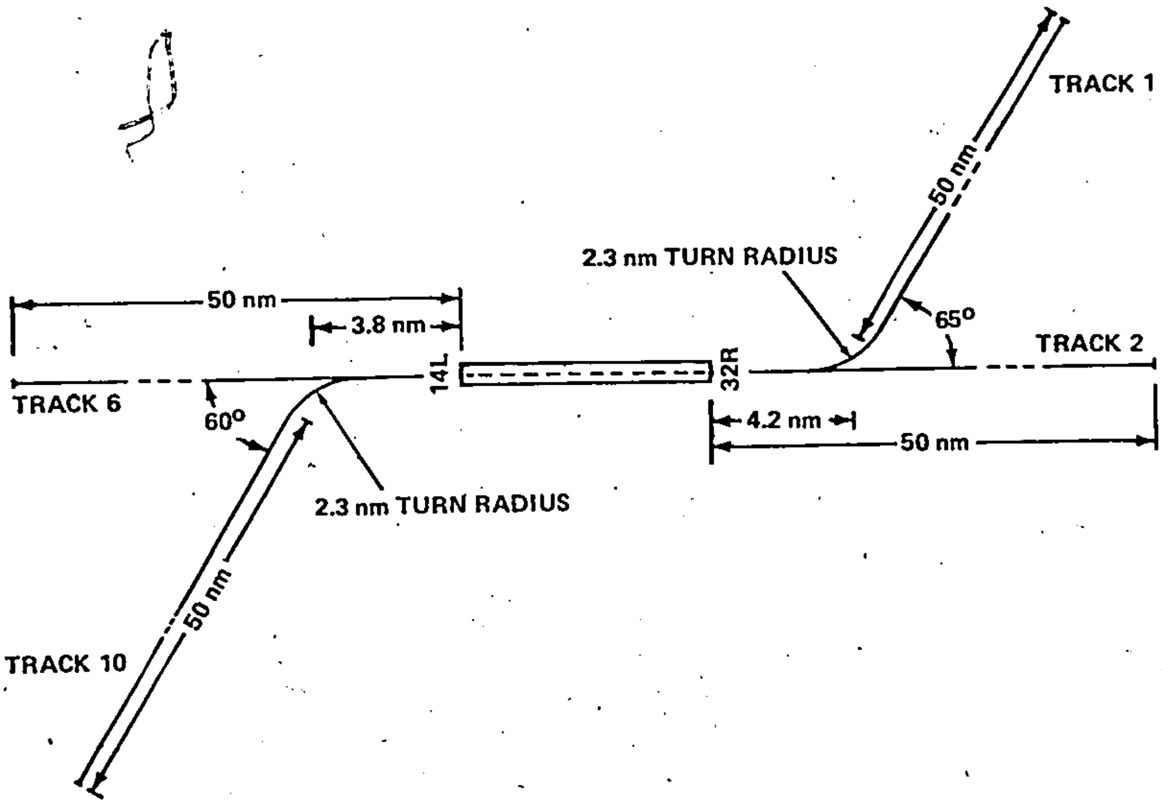


Figure 3.3: Tracks 1, 2, 6 and 10 of Runways 14L - 32R

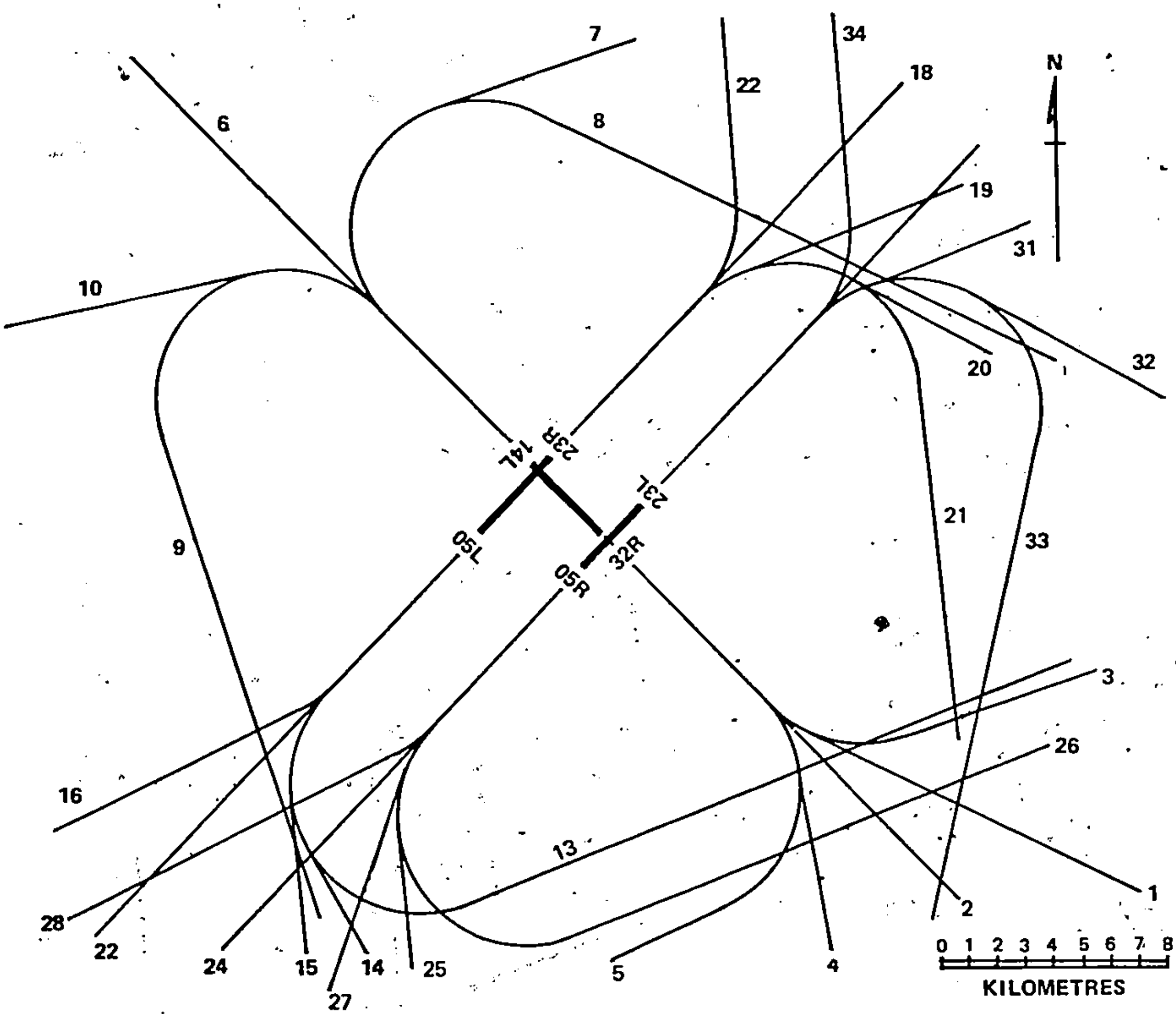


Figure 3.4: Runways and Tracks

TABLE 3.1. RWY 14L 32R

TRACK No.	FIRST SEGMENT	SECOND SEGMENT		THIRD SEGMENT
		ANGLE	TURN RADIUS	
1	4.2 n.m.	65°	-2.3 n.m.	50 n.m.
3	4.2 n.m.	20°	-2.3 n.m.	50 n.m.
4	4.2 n.m.	35°	2.3 n.m.	50 n.m.
5	4.2 n.m.	110°	2.3 n.m.	50 n.m.
7	3.8 n.m.	115°	2.3 n.m.	50 n.m.
8	3.8 n.m.	160°	2.3 n.m.	50 n.m.
9	3.8 n.m.	155°	-2.3 n.m.	50 n.m.
10	3.8 n.m.	60°	-2.3 n.m.	
Track 2 and 6 are landing tracks, each with one straight 50 n.m. segment				

TABLE 3.2. RWY 05L 23R

TRACK No.	FIRST SEGMENT	SECOND SEGMENT		THIRD SEGMENT
		ANGLE	TURN RADIUS	
13	4.1 n.m.	115°	-2.3 n.m.	50 n.m.
14	4.1 n.m.	105°	-2.3 n.m.	50 n.m.
15	4.1 n.m.	50°	-2.3 n.m.	50 n.m.
16	4.1 n.m.	20°	2.3 n.m.	50 n.m.
19	3.8 n.m.	25°	2.3 n.m.	50 n.m.
20	3.8 n.m.	75°	2.3 n.m.	50 n.m.
21	3.8 n.m.	130°	2.3 n.m.	50 n.m.
22	3.8 n.m.	50°	-2.3 n.m.	50 n.m.
Track 12 and 18 are landing tracks each with one straight 50 n.m. segment.				

TABLE 3.3. RWY 23 L 05R

TRACK No.	FIRST SEGMENT	SECOND SEGMENT		THIRD SEGMENT
		ANGLE	TURN RADIUS	
25	3.9 n.m.	155°	-2.3 n.m.	50 n.m.
26	3.9 n.m.	105°	-2.3 n.m.	50 n.m.
27	3.9 n.m.	50°	-2.3 n.m.	50 n.m.
28	3.9 n.m.	20°	2.3 n.m.	50 n.m.
31	4.6 n.m.	25°	2.3 n.m.	50 n.m.
32	4.6 n.m.	75°	2.3 n.m.	50 n.m.
33	4.6 n.m.	150°	2.3 n.m.	50 n.m.
34	4.6 n.m.	50°	-2.3 n.m.	50 n.m.
Track 24 and 30 are landing tracks, each with one straight 50 n.m. segment.				

There are two outer markers for each runway, one at a fixed distance from each end of the runway. Department of Energy, Mines and Resources (AIR CANADA PILOT) provided the outer markers distances in n.m. for each runway of Toronto International Airport, shown in Table 3.4.

TABLE 3.4. OUTER MARKERS
DISTANCES FROM THE END OF RUNWAYS

RWY		OUTER MARKER
14L	32R	4.2 n.m.
32R	14L	3.8 n.m.
23R	05L	4.1 n.m.
05L	23R	3.8 n.m.
23L	05R	3.9 n.m.
05R	23L	4.6 n.m.

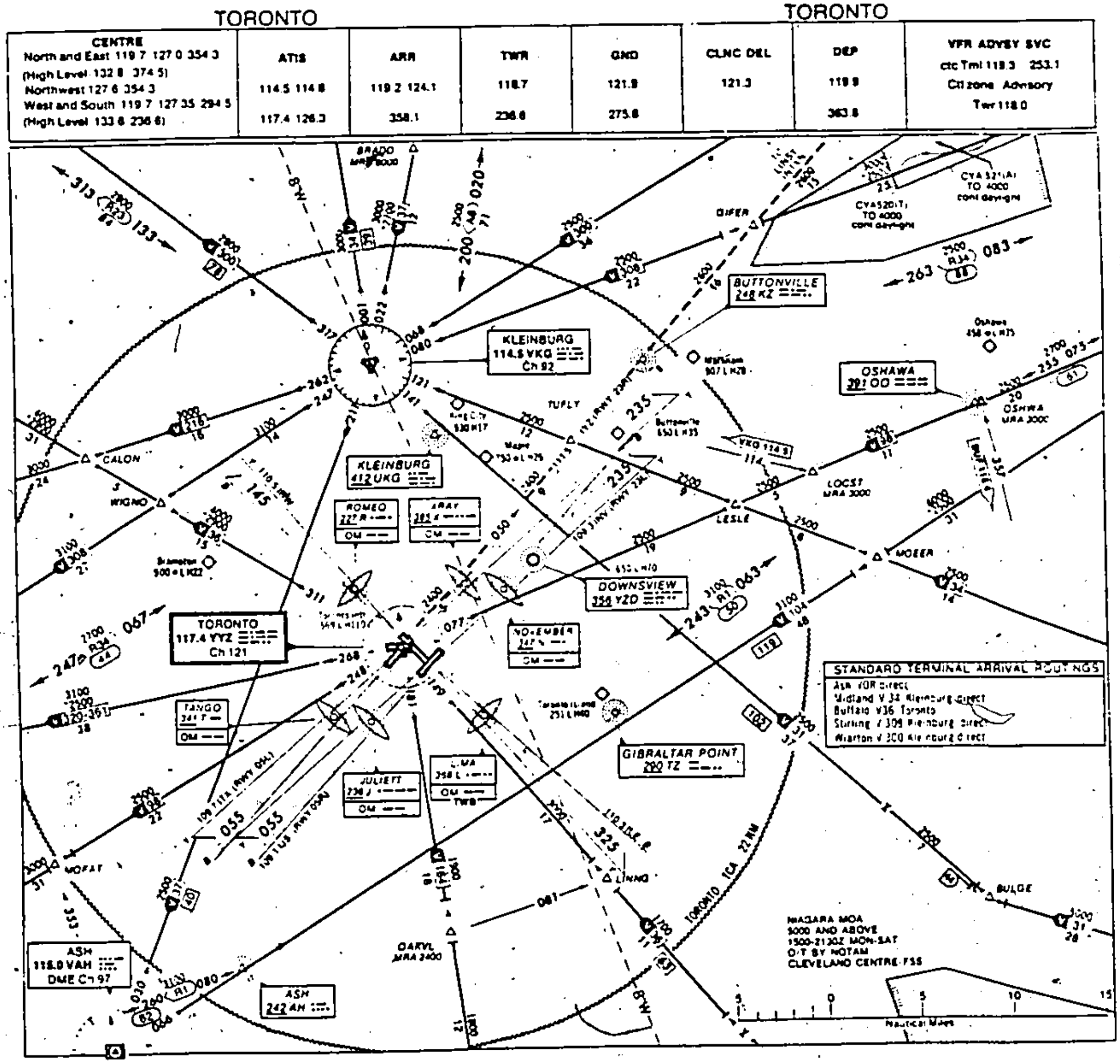


Fig. 3.5: AIRWAYS VECTORS

SOURCE: DEPARTMENT OF ENERGY, MINES AND RESOURCES (AIR CANADA PILOT).

Poor Copy

3.3 Landing Profile

A 3° Glide Slope is used for the approach profile. The landing profile is divided into 6 segments (see Fig. 3.6). Given altitudes at each segment, distances from runway end were calculated. The INM program data base provides the corresponding velocities for the indicators for the first four segments, and also provides the thrusts for the indicators of the segments (Tables 3.5 and 3.6).

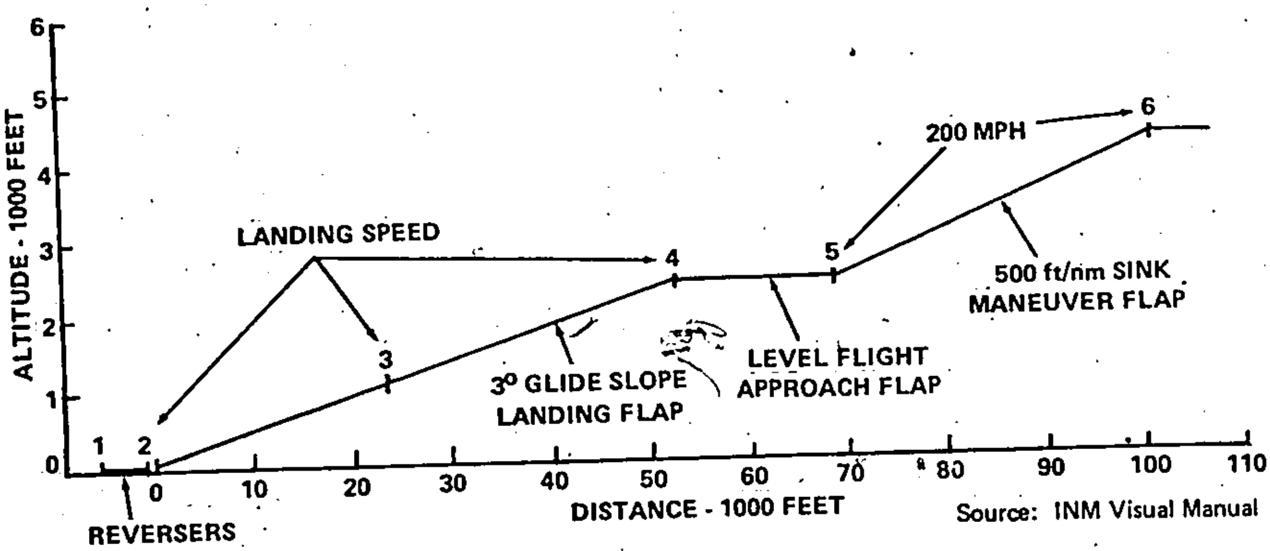


Figure 3.6: LANDING PROFILE

TABLE 3.5. LANDING PROFILE

SEGMENT	DISTANCES FROM RWY END	ALTITUDES	VELOCITIES	THRUSTS*
1	-1.0	0.0		-10
2	-0.165	0.0	-2	- 3
3	3.14	1000	-2	- 3
4	9.42	3000	-2	- 5
5	12.56	3000	200 n.m.	- 8
6	17.27	5500	200 n.m.	

* See Table 3.6.

SOURCE: INM user manual.

TABLE 3.6. INDICATORS

1	Stop distance
2	Landing speed
3	Thrust for 3° Glide Slope Landing flap
4	Thrust for 6° Glide Slope Landing flap
5	Thrust for Level flight approach flap
6	Thrust for 3° Glide approach flap
7	Thurst for Level flight maneuver flap
8	Thrust for 500 ft/nm sink maneuver flap
9	Idle thrust
10	Reversal thrust

SOURCE: INM user manual

For takeoff operations aircraft initiate their turns at the outer marker. This distance is considered as the first segment for each curved track for organizing the input data for the INM (Ref. 12).

The third segment in each track represents the airway vector for flight operations. Table 3.7 provides us with airways vectors used in this study, and Fig. 3.5 shows all airways vectors.

TABLE 3.7. AIRWAYS VECTORS

*ANGLE	AIRWAYS VECTOR	DIRECTION OF DESTINATION	EXAMPLE OF DIRECTION	*ANGLE
115°	V 98	East	Ottawa, Montreal, North Atlantic.	65°
160°	V 34	U.S. East	New York, Boston, Washington.	20°
155°	V 164	South	Florida, Caribbean, Mexico, South America	35°
60°	V 361	South West	Windsor, Chicago, San Francisco	110°

* The angle between the third segment and the center line of the runway.

SOURCE: TRANSPORT CANADA, TORONTO.

3.4 Traffic Mix

The aircraft traffic mix describes the average daily number of aircraft operations by type, ground track, approach profile number and time of day at the airport. The Statistics and Forecast Division of Transport Canada supplied the number of aircraft movements for the three summer months (June, July and August) of 1977 at Toronto International Airport (see Appendix 1).

Aircraft during the summer period of 1977 have been determined to be composed of scheduled air carriers using the following aircraft:

1. DC-9-32
2. B-727-200
3. B-707-320 B/C
4. B-7-7-120/320
5. DC-10-10
6. B-747-200

and of non-scheduled operation -

7. SABRELINER
8. TWIN OTTER
9. CESSNA 310

The operation of aircraft were divided into three categories as follows:

DAY = 0700 to 1659 hours

EVENING = 1700 to 2159 hours

NIGHT = 2200 to 0659 hours

The unusual time span for the evening is because the output provides us with the CNEL metric. The CNEL with its 5 dB penalty for evening operations is used widely in U.S. specially in California. The division of the INM for day, evening, and night did not affect the values of the L_{dn} for this study, which divided the day into two categories: daytime from 0700 hours to 2200 hours and the nightime from 2200 hours to 0659 hours.

The total number of operations for each category were summed up and divided by 90 to obtain the typical daily operation. Table 3.8 shows the summary for the arrivals and Table 3.9 shows the total takeoffs and landings.

The distribution of aircraft movements (landings and takeoffs) to their specific tracks was done according to flight destination, which assigns the aircraft to its corresponding track. The traffic mix data was followed by the grid points concluding the organization of the input data. The limited capacity of the McMaster Computer Centre was insufficient to run the exceptionally large INM programme. The punched data were sent to the U.S.A., and were run on the United Computing Service system.

TABLE 3.8. ARRIVALS

TYPE 1: DC-9-32

RWY	DAY	EVENING	NIGHT
05L	378	234	9
05R	900	594	207
14L	900	396	261
23L	1260	990	81
23R	342	342	9
32R	639	288	8

TYPE 5: B-727-200

RWY	DAY	EVENING	NIGHT
05L	135	99	18
05R	351	234	153
14L	333	153	162
23L	441	378	72
23R	135	135	18
32R	216	108	

TYPE 8: B-707-120B

RWY	DAY	EVENING	NIGHT
05L	135	90	
05R	324	198	144
14L	351	126	180
23L	450	333	54
23R	126	108	18
32R	207	90	

TABLE 3.8. ARRIVALS (Cont'd.)

TYPE 13: B-707-120/320

RWY	DAY	EVENING	NIGHT
05L		9	
05R	45	9	9
14L	18	18	9
23L	45	36	9
23R	18	9	
32R	27	18	

TYPE 21: DC-10-10

RWY	DAY	EVENING	NIGHT
05L	63	90	9
05R	198	207	63
14L	180	171	81
23L	279	342	45
23R	63	126	9
32R	126	99	

TYPE 25: B-747-200

RWY	DAY	EVENING	NIGHT
05L	27	36	
05R	72	90	9
14L	72	72	27
23L	117	144	9
23R	27	63	9
32R	72	36	

TABLE 3.8. ARRIVALS (Cont'd.)

TYPE 38: SABRELINER

RWY	DAY	EVENING	NIGHT
05L	171	126	45
05R	108	36	27
14L	216	81	45
23L	81	63	9
23R	270	225	18
32R	189	90	

TYPE 39: TWIN OTTER

RWY	DAY	EVENING	NIGHT
05L	135	99	27
05$	207	108	27
14L	225	90	45
23L	225	198	18
23R	207	171	9
32R	198	90	9

TYPE 40: CESSNA 310

RWY	DAY	EVENING	NIGHT
05L	549	468	162
05R	81	54	126
14L	261	72	117
23L	72	72	36
23R	585	540	144
32R	405	117	81

TABLE 3.9. TOTAL TAKEOFFS AND LANDINGS

	TYPE OF AIRCRAFT	TOTAL ARRIVALS	TOTAL DEPARTURES
1	DC-9-32	7796	7736
2	B-727-200	3128	2181
3	B-707-120	2957	2915
4	B-707-120/320	271	325
5	DC-10-10	2152	2082
6	B-747-200	878	871
7	SABRELINER	1797	1809
8	TWIN OTTER	2075	2072
9	CESSNA 310	3946	4074

TOTAL OPERATIONS:

Arrivals:* 25,000 - Daily Average = 277.78

Departures: 25,065 - Daily Average = 278.50

* Differences between number of arrivals and departures are because some aircraft are grounded overnight or longer and others require maintenance and overhaul check ups.

CHAPTER 4

ANALYSIS OF MEASUREMENT

Research in psychoacoustics has revealed that attitudes, beliefs and values of individuals may greatly influence the degree to which a person considers a given sound annoying. At a particular noise level, community response usually includes some percentage of people highly annoyed, some percentage of people moderately annoyed and others are not annoyed at all. This chapter explains the predictive ability of noise metrics and the analysis of measurements. The first section of this chapter describes the social survey data. The second section explains the analysis and the results, followed by section three, which closes this Chapter with a brief summary.

4.1 Social Survey Data

The response data were derived from the social survey conducted in the summer of 1978 (June, July and August) at 56 residential sites in the vicinity of Toronto International Airport to represent people's judgement to aircraft fly-overs using a household questionnaire. A total of 673 interviews (Ref. 10) were obtained from the 965 households at the 56 sites. Appendix 2 shows a copy of the questionnaire and Appendix 3 shows a copy map of the airport, showing the approximate location of each site. Each site was categorized according to 1979 NEF forecast levels provided by Transport Canada (Table 4.1), the location of the site relative to the flight path, and the presence or absence of road traffic noise.

TABLE 4.1: NUMBER OF SITES BY NOISE LEVEL

NEF	40	35-40	30-35	30
# SITES	3	16	18	19

From the 673 completed interviews 88 percent mentioned hearing aircraft noise and 74 percent were annoyed by aircraft noise. (Ref. 9).

For the analysis of this study, the dependent variable used is the percentage of respondents at each site who mentioned a certain effect. The four categories of aggregate responses selected for this study are as follows:

1. the percent of respondents who are highly annoyed by aircraft noise (question 2, see Appendix 2);
2. the percent of respondents reporting speech interference (questions 3 and 4);

3. the percent reporting sleep interruption (questions 6 and 7);
4. the percent who mentioned having taken some form of complaint action (question 10).

4.2 Analysis Methods and Results

The INM provided us with physical data in terms of NEF, L_{eq}, and L_{dn}. Table 4.2 gives values of NEF, L_{eq} and L_{dn} for each of the 56 sites (see Appendix 4).

TABLE 4.2: NOISE EXPOSURE VALUES

SITE No.	NEF	L_{eq}	L_{dn}	SITE No.	NEF	L_{eq}	L_{dn}
1	39.9	71.7	74.7	29	22.5	55.5	57.0
2	38.2	70.4	73.2	30	22.2	56.1	58.6
3	36.0	68.6	71.3	31	24.6	59.1	61.2
4	31.5	64.7	67.2	32	22.5	57.3	59.3
5	31.0	64.4	66.9	33	22.8	58.0	59.5
6	30.8	64.3	66.6	34	35.0	67.5	69.1
7	30.5	64.1	66.3	35	28.7	61.7	63.2
8	21.8	56.6	58.6	36	34.2	66.6	68.2
9	31.8	64.0	67.1	37	22.1	57.1	58.2
10	31.8	64.0	67.1	38	32.0	64.7	66.3
11	23.7	57.1	59.8	39	25.9	59.8	61.3
12	27.4	60.5	63.2	40	25.5	59.0	60.5
13	31.3	63.6	66.5	41	26.2	59.5	61.1
14	24.7	58.1	60.7	42	32.7	65.9	66.6
15	28.2	61.0	63.7	43	29.9	62.9	63.8
16	29.1	63.1	64.9	44	32.3	65.6	66.2
17	20.5	55.6	57.0	45	29.7	62.7	63.6
18	27.1	60.2	61.6	46	32.0	65.3	66.0
19	30.1	62.6	64.0	47	26.2	59.2	60.4
20	29.2	61.8	63.1	48	30.1	63.5	64.2
21	21.3	54.9	56.3	49	29.7	63.2	63.8
22	23.0	56.1	57.5	50	25.7	58.7	60.0
23	23.4	56.3	57.8	51	27.6	60.4	61.1
24	23.2	56.1	57.6	52	25.4	57.9	58.9
25	22.1	55.4	56.9	53	27.5	62.1	63.7
26	21.8	55.0	56.5	54	27.4	59.6	62.5
27	22.6	55.6	57.1	55	25.8	59.0	61.6
28	22.0	55.1	56.6	56	26.4	59.2	61.4

Table 4.3 gives the regression equations and correlation coefficients for these variables, which show a very high degree of correlation.

TABLE 4.3
LINEAR REGRESSION EQUATIONS FOR NOISE METRICS

L_{eq}	=	0.88 NEF + 36.35
r^2	=	0.97
r	=	0.98
L_{dn}	=	0.93 NEF + 36.68
r^2	=	0.95
r	=	0.97

From Table 4.3 correlation among L_{eq}, L_{dn} and NEF implies there will not be much variation in relationships with response.

The scatter plot of Fig. 4.1 shows noise events in terms of L_{eq} and NEF and the scatter plot of Fig. 4.2. represents noise events in terms of L_{dn} and NEF.

In reviewing the data from the 56 sites near Toronto International Airport, L_{eq} fell 2 to 3.1 dBA lower than L_{dn} at 22 sites, 1 to 1.6 dBA lower than L_{dn} at 26 sites, 0.5 to 0.9 dBA lower than L_{dn} at 8 sites. These differences between L_{dn} and L_{eq} are listed in Table 4.4.

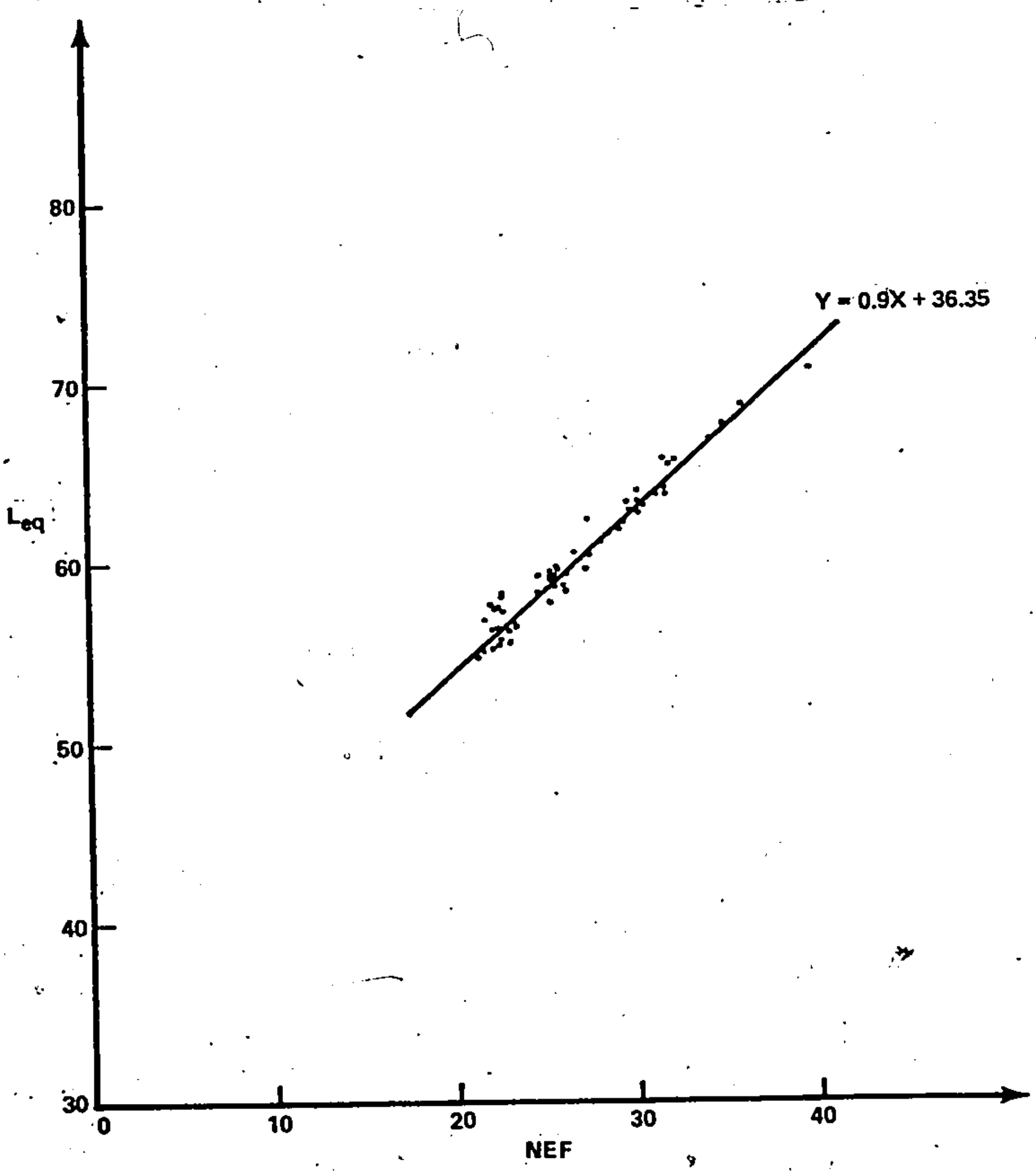


Figure 4.1: L_{eq} and NEF Scatter plot for Noise Events Data at 56 Sites.

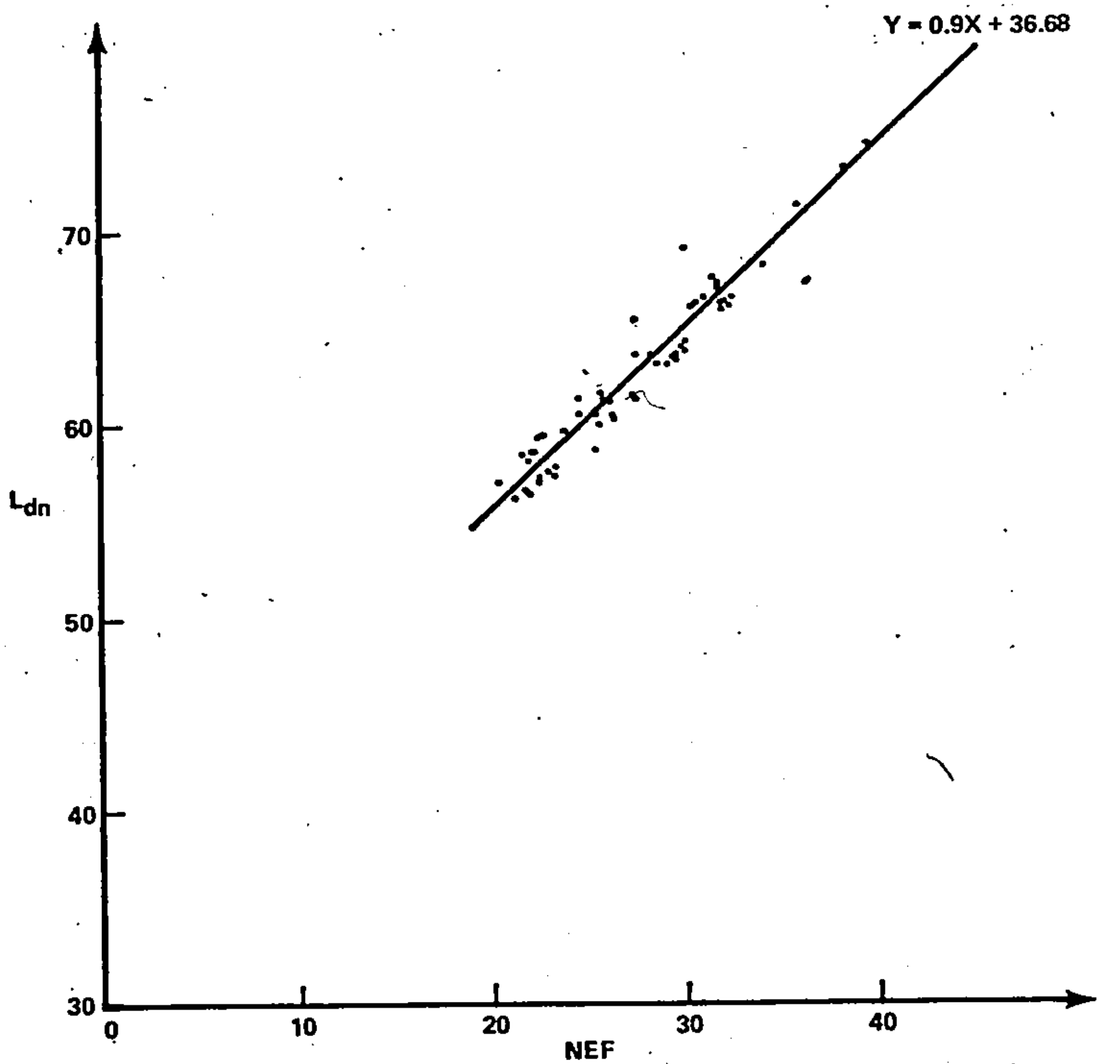


Figure 4.2: L_{dn} and NEF Scatter plot for Noise Events Data at 56 Sites.

TABLE 4.4: $L_{dn} - L_{eq}$			
$L_{dn} - L_{eq}$	2 to 3.1	1 to 1.6	0.5 to 0.9
# Sites	22	26	8

It has been mentioned in Chapter 2, that a 10 dB night penalty distinguishes L_{dn} from L_{eq} and a normalization process equalizes both descriptors if night levels are lower 10 dB than in the day. In fact, an unusual increase of night traffic mix represents a significant difference between L_{dn} and L_{eq}. However, scheduled flights are not permitted at Toronto International Airport due to night traffic curfew, which explains the small differences between L_{dn} and L_{eq} values.

The remainder of this section is to identify functions relating to noise levels and four response variables reporting speech interference, sleep interruption, complaints and high annoyance at aircraft noise experienced by people living around Toronto International Airport. As mentioned earlier in Chapter 1, regression analyses are used to determine how well noise measurements predict response.

Percent Speech Interference

The statistical coefficient for the three metrics for speech interference are represented in Table 4.5.

TABLE 4.5: STATISTICAL COEFFICIENTS FOR SPEECH INTERFERENCE.

	NEF	L_{eq}	L_{dn}
Intercept	-25.5	-142.7	-120.6
Slope	3.05	3.31	2.86
r	.6159	.6089	.5517
Significant (r)	.001	.001	.001
r^2	.38	.37	.30

The results described "percent speech interference" as a function of NEF, L_{eq}, and L_{dn} by the following relationship:

$$\% \text{ Speech Interference} = 3.05 \text{ NEF} - 25.5 \quad 4.1$$
$$\% \text{ Speech Interference} = 3.31 L_{eq} - 142.7 \quad 4.2$$
$$\% \text{ Speech Interference} = 2.86 L_{dn} - 120.6 \quad 4.3$$

In essence, these relationships predict no people having speech interference at NEF = 8.36, or at L_{eq} = 43.1, or at L_{dn} = 42.16. However, from Table 4.5 the coefficient of determination r^2 = .38 means that 38% of the total variance in the percentage of people reporting speech interference is explained by the regression equation 4.1 for NEF values. Thirty-seven percent of the total variance in percentage of people reporting speech interference is explained by the regression equation 4.2 for L_{eq} values, while only 30% of the total variance in percentage of people reporting speech interference is explained by the regression equation 4.3 for L_{dn} values.

Table 4.6 represents percent of people disturbance (speech interference) at various levels.

TABLE 4.6: % SPEECH INTERFERENCE AT VARIOUS NOISE LEVELS

NEF				
NEF	35	30	28	8.36
% Speech Interference	81.25	66	59.9	0
L_{eq}				
L_{eq}	68	63	61	43.1
% Speech Interference	82.38	65.8	59.21	0
L_{dn}				
L_{dn}	71	66	63	42.16
% Speech Interference	82.46	68.16	59.58	0

Figures 4.3, 4.4 and 4.5 indicate that a linear fit is as good as any other.

The significance of the differences in these correlation coefficients (Table 4.5) can be calculated as follows. The variable Z, calculated as follows, has a normal or Gaussian distribution (N (0.1)):

$$Z = \frac{\frac{1}{2} \text{Ln} \left[(1 + r_1) / (1 - r_1)\right] - \frac{1}{2} \text{Ln} \left[(1 + r_2) / (1 - r_2)\right]}{\sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}}$$

For the two correlation coefficients in Table 4.5 with the greatest difference, $n_1 = n_2 = 56$ (sites), $r_1 = 0.6159$ for NEF, $r_2 = 0.5517$ for L_{dn}, and

$$Z = \frac{\frac{1}{2} \text{Ln} (1.6159 / 0.3841) - \frac{1}{2} \text{Ln} (1.5517 / 0.4483)}{\sqrt{\frac{1}{53} + \frac{1}{53}}}$$

$$Z = 0.5024$$

For 95% confidence Z must be greater than or equal to 1.96. Hence one must conclude that the difference between these r values for NEF and L_{dn} is not significant. Obviously, the smaller difference between L_{eq} and each of these is also not statistically significant.

AGGREGATED RESPONSE BY SITE

FILE NONAME (CREATION DATE = 79/02/07.)
SCATTERGRAM OF (DOWN) TALKAC (ACROSS) NEF

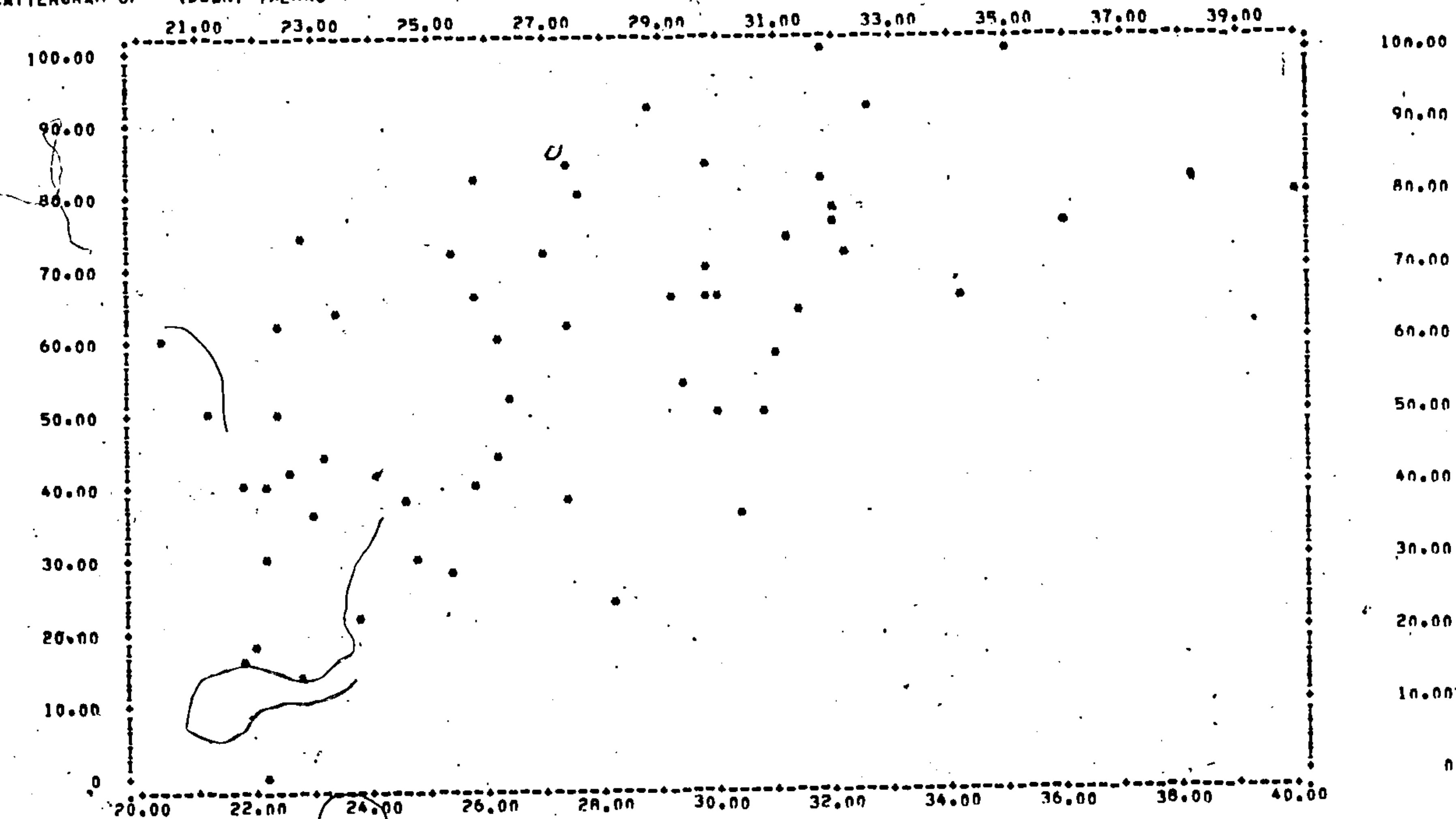


Fig. 4.3: PERCENT SPEECH INTERFERENCE AGAINST NEF

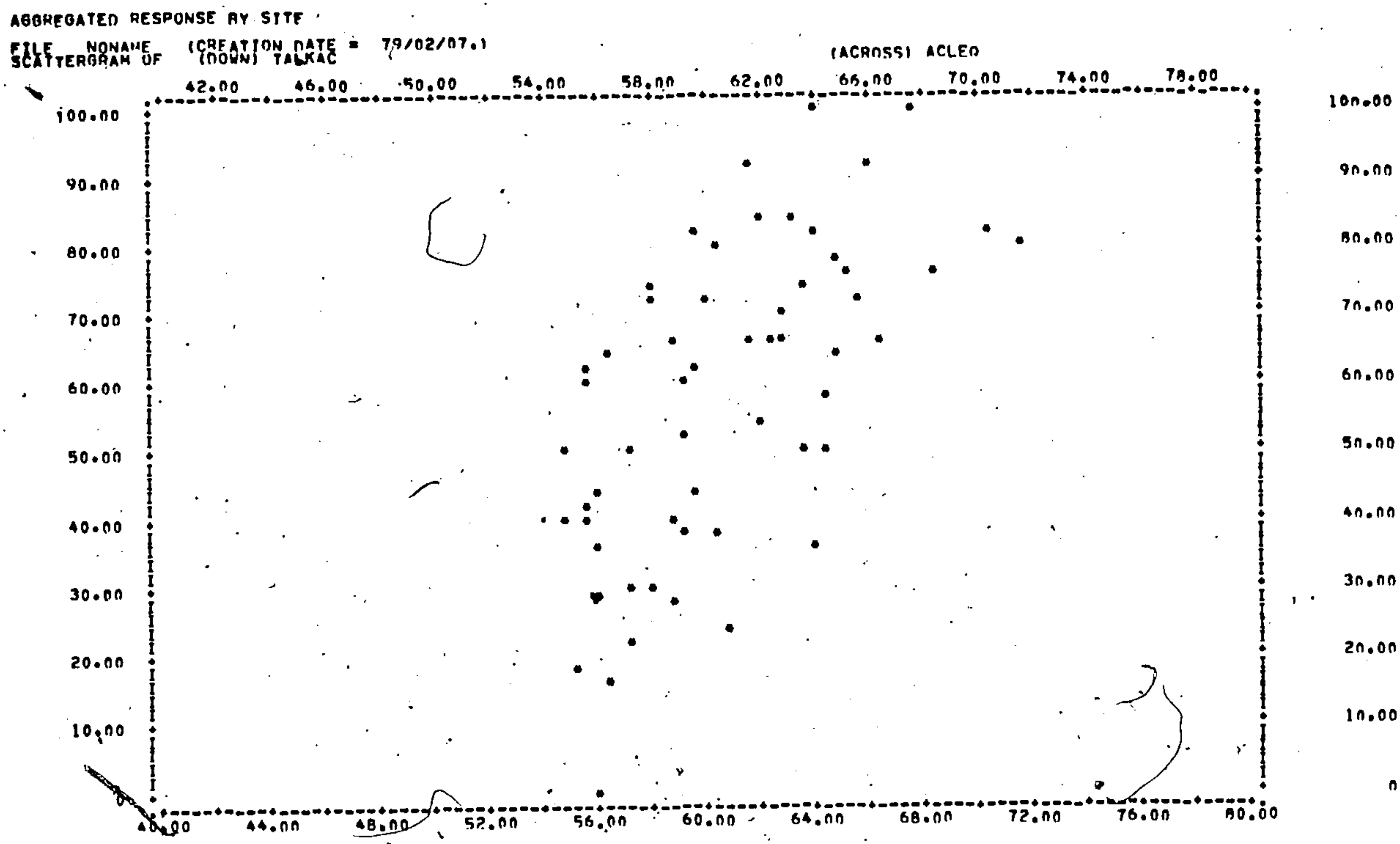


Fig. 4.4: PERCENT SPEECH INTERFERENCE AGAINST L_{eq}

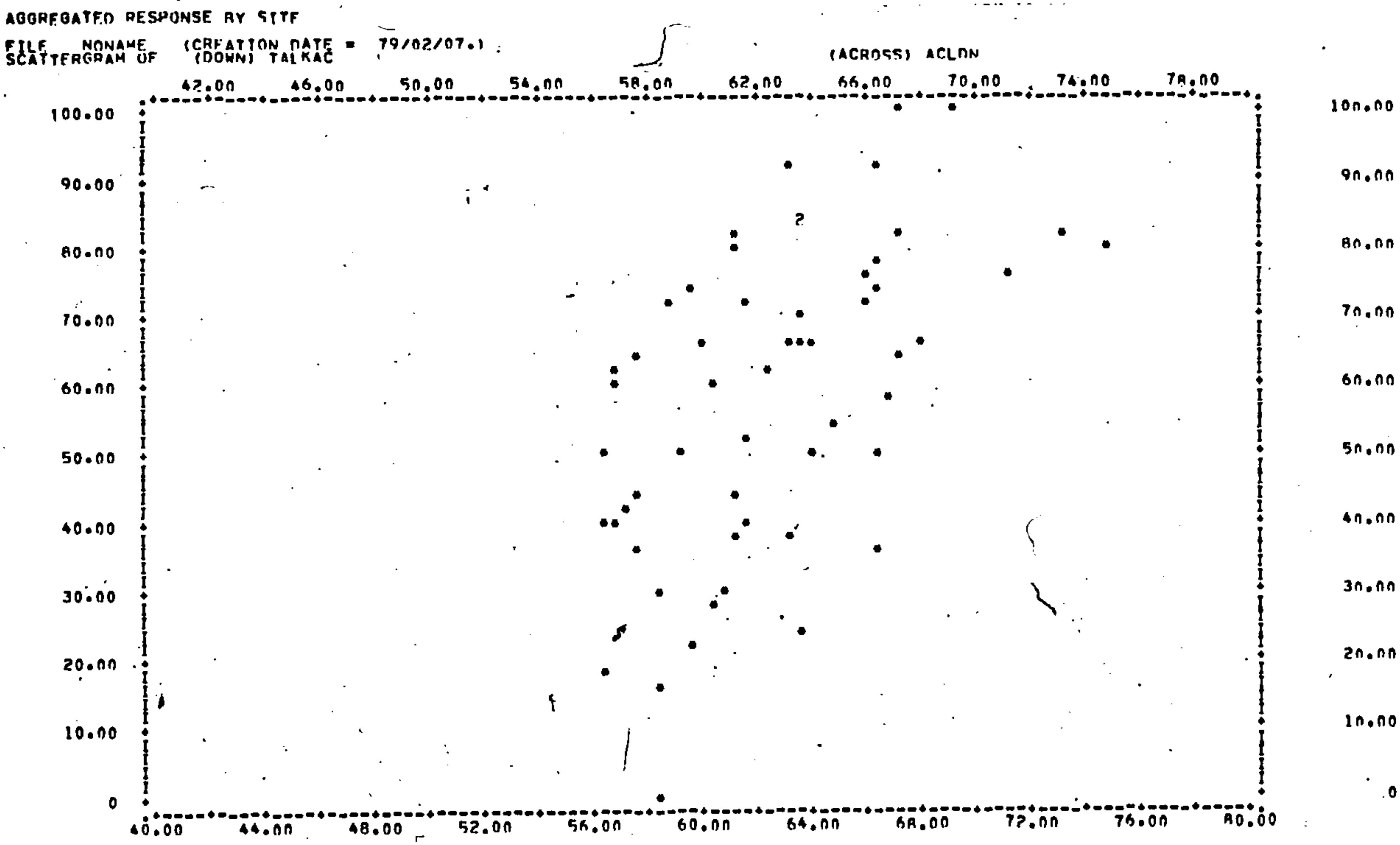


Fig. 4.5: PERCENT SPEECH INTERFERENCE AGAINST L_{dn}

Percent Sleep Interruption

The statistical coefficients for the three noise descriptors for the sleep interruption are represented in Table 4.7.

TABLE 4.7: STATISTICAL COEFFICIENT OF SLEEP INTERRUPTION

	NEF	L_{eq}	L_{dn}
INTERCEPT	-11.5	-62.4	-58.3
SLOPE	1.33	1.44	1.33
r	.3784	.3725	.3614
SIGNIFICANCE (r)	.002	.002	.003
r^2	.14	.14	.13

The results described "percent sleep interruption" as a function of NEF, L_{eq} and L_{dn} by the following relationships:

% Sleep Interruption = 1.33 NEF - 11.5 4.4
% Sleep Interruption = 1.44 L_{eq} - 62.4 4.5
% Sleep Interruption = 1.33 L_{dn} - 58.3 4.6

In essence, these relationships predict no people reporting sleep disturbance at NEF = 8.65 or at L_{eq} = 43.33 dBA or at L_{dn} = 43.83 dBA. However, from Table 19 the coefficient of determination r^2 = .14 means that only 14% of the total variance in the percentage of people reporting sleep interruption is explained by the regression equations 4.4 and 4.5 for NEF and L_{eq} values. Thirteen percent of the total variance in the percentage of people reporting sleep interruption is explained by the regression equation 4.6 for L_{dn} values.

Table 4.8 represents percent of people disturbance (sleep interruption) at various levels.

TABLE 4.8: % SLEEP INTERRUPTION AT VARIOUS NOISE LEVELS

NEF				
NEF	35	30	28	8.65
% Sleep Interrup.	35.05	28.4	25.7	0
L_{eq}				
L_{eq}	68	63	61	43.33
% Sleep Interrup.	35.5	28.3	25.4	0
L_{dn}				
L_{dn}	71	66	63	43.83
% Sleep Interrup.	36.13	29.48	25.49	0

Figures 4.6, 4.7 and 4.8 indicate that a linear fit is as good as any other. From Table 4.7 we can see that correlations between variables are poor and it is not a good fit and here again the results show noise metrics are considered to be equal in predicting percent of people reporting sleep interruptions.

AGGREGATED RESPONSE BY SITE

FILE NONAME (CREATION DATE = 79/02/07.)
SCATTERGRAM OF (DOWN) SLEEPAC

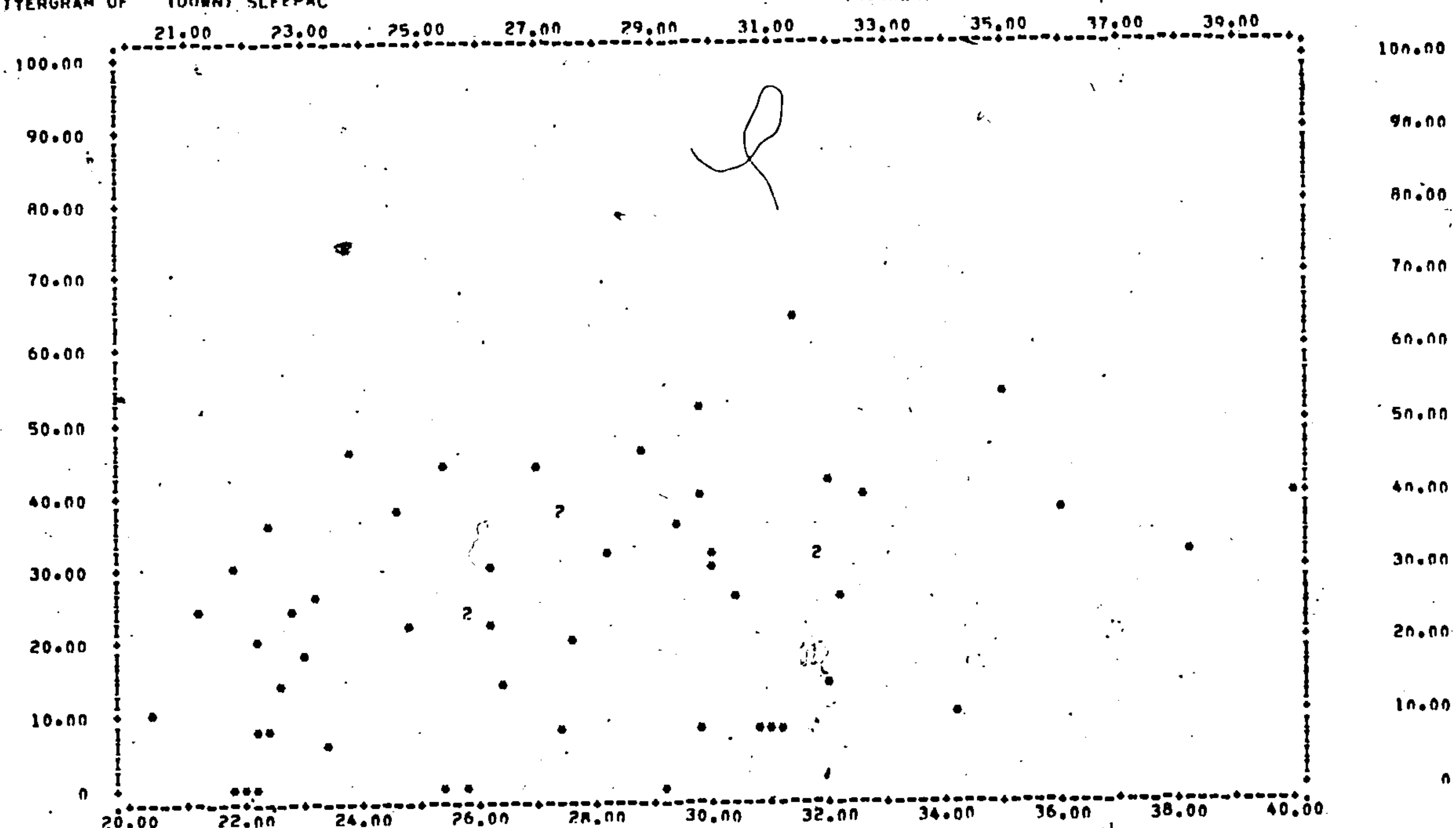


Fig. 4.6: PERCENT SLEEP INTERRUPTION AGAINST NEF

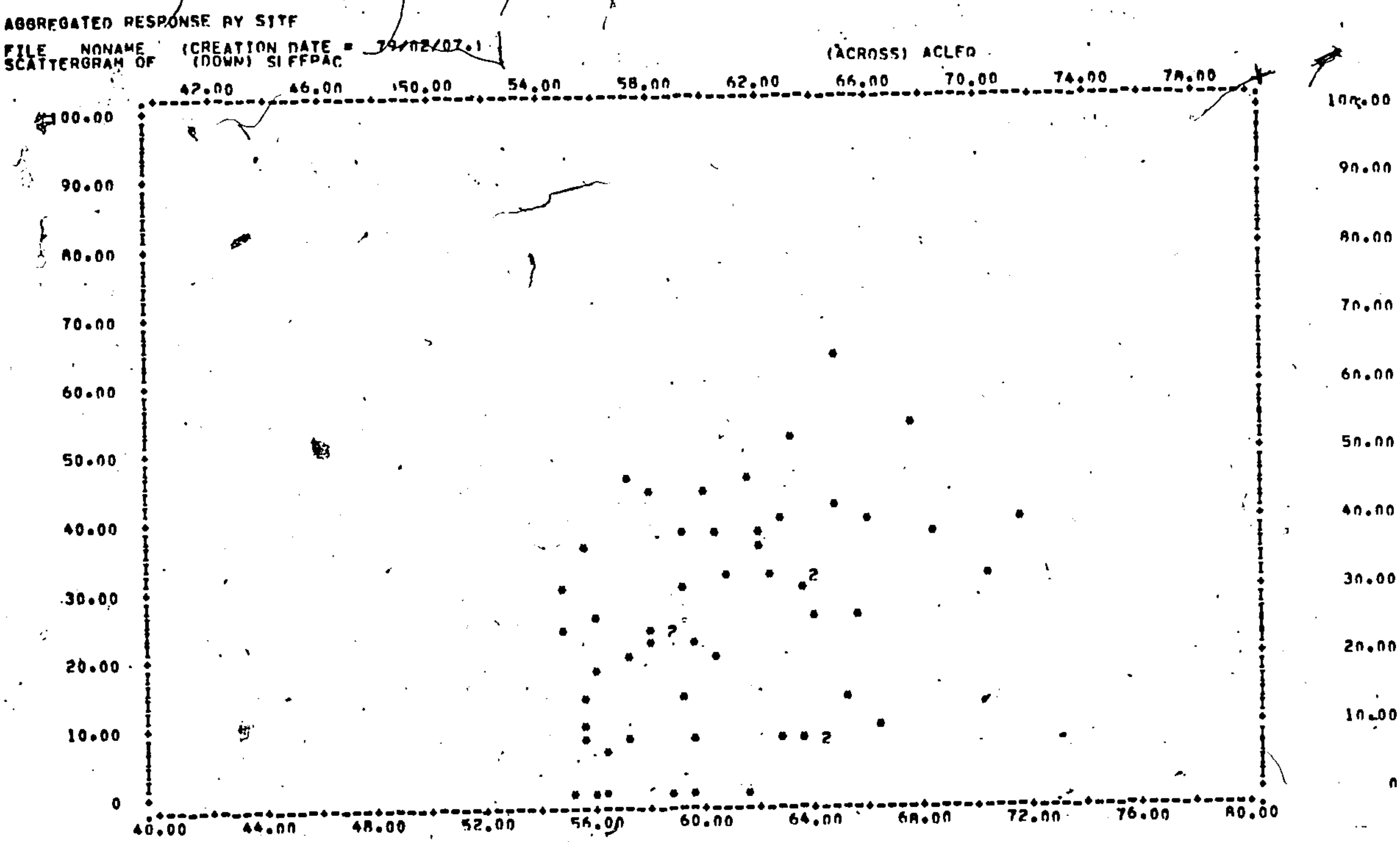


Fig. 4.7: PERCENT SLEEP INTERRUPTION AGAINST L_{eq}

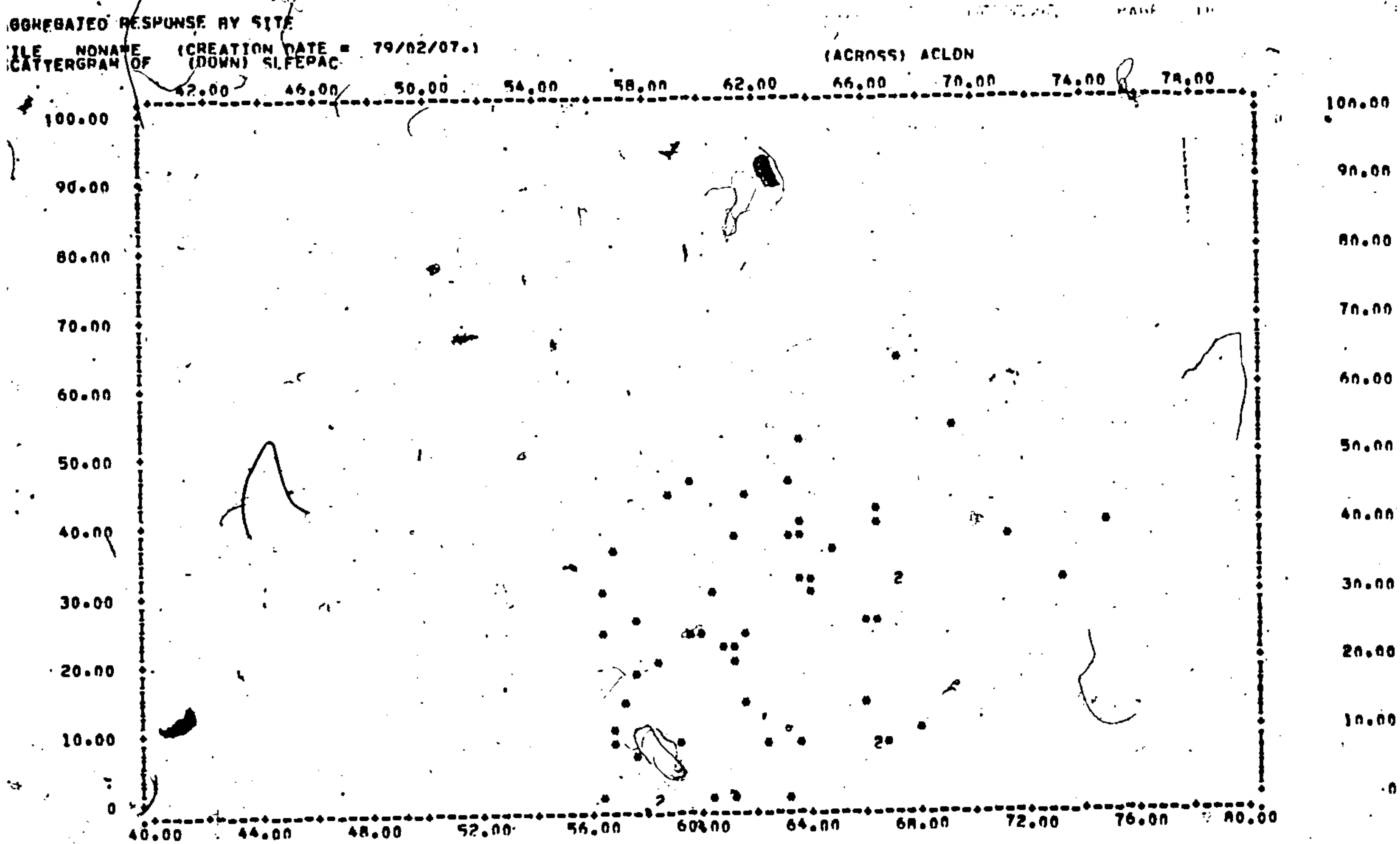


Fig. 4.8: PERCENT SLEEP INTERRUPTION AGAINST L_{dn}

Percent Complaints

The statistical coefficients for the three noise descriptors for complaints are presented in Table 4.9.

TABLE 4.9: STATISTICAL COEFFICIENTS FOR COMPLAINTS

	NEF	L_{eq}	L_{dn}
Intercept	- 8.1	-35.7	-22.0
Slope	.88	.85	.61
r	.2200	.1930	.1431
Significance (r)	.051	.077	.143
r^2	.05	.04	.02

The results described "% complaints" as a function of NEF, L_{eq} and L_{dn} by the following relationships:

$$\% \text{ complaints} = -8.1 + .88 \text{ NEF} \quad 4.7$$

$$\% \text{ complaints} = -35.7 + .85 L_{eq} \quad 4.8$$

$$\% \text{ complaints} = -22 + .61 L_{dn} \quad 4.9$$

In essence, these relationships predict no people reporting complaints at NEF ≅ 9.2 or L_{eq} = 42 dBA or L_{dn} = 36.06 dBA. However, from Table 21 the coefficient of determination r^2 = .05 means that only 5% of the total variance in the percentage of people reporting complaints is explained by the regression equation 4.7 for NEF values and only 4% and 2% are explained by the regression equations 4.8 and 4.9 respectively.

Table 4.10 represents percent of people reporting complaints at various noise levels.

TABLE 4.10: % COMPLAINTS AT VARIOUS NOISE LEVELS				
NEF				
NEF	35	30	28	9.2
% Complaints	22.7	18.3	16.54	0
L_{eq}				
L_{eq}	68	63	61	42
% Complaints	22.1	17.8	16.15	0
L_{dn}				
L_{dn}	71	66	63	36.06
% Complaints	21.31	18.26	16.43	0

Figures 4.9, 4.10 and 4.11 indicate that a linear fit is as good as any other. The correlations are very poor and the slopes are almost flat, and again the noise metrics are equal in predicting percent complaints.

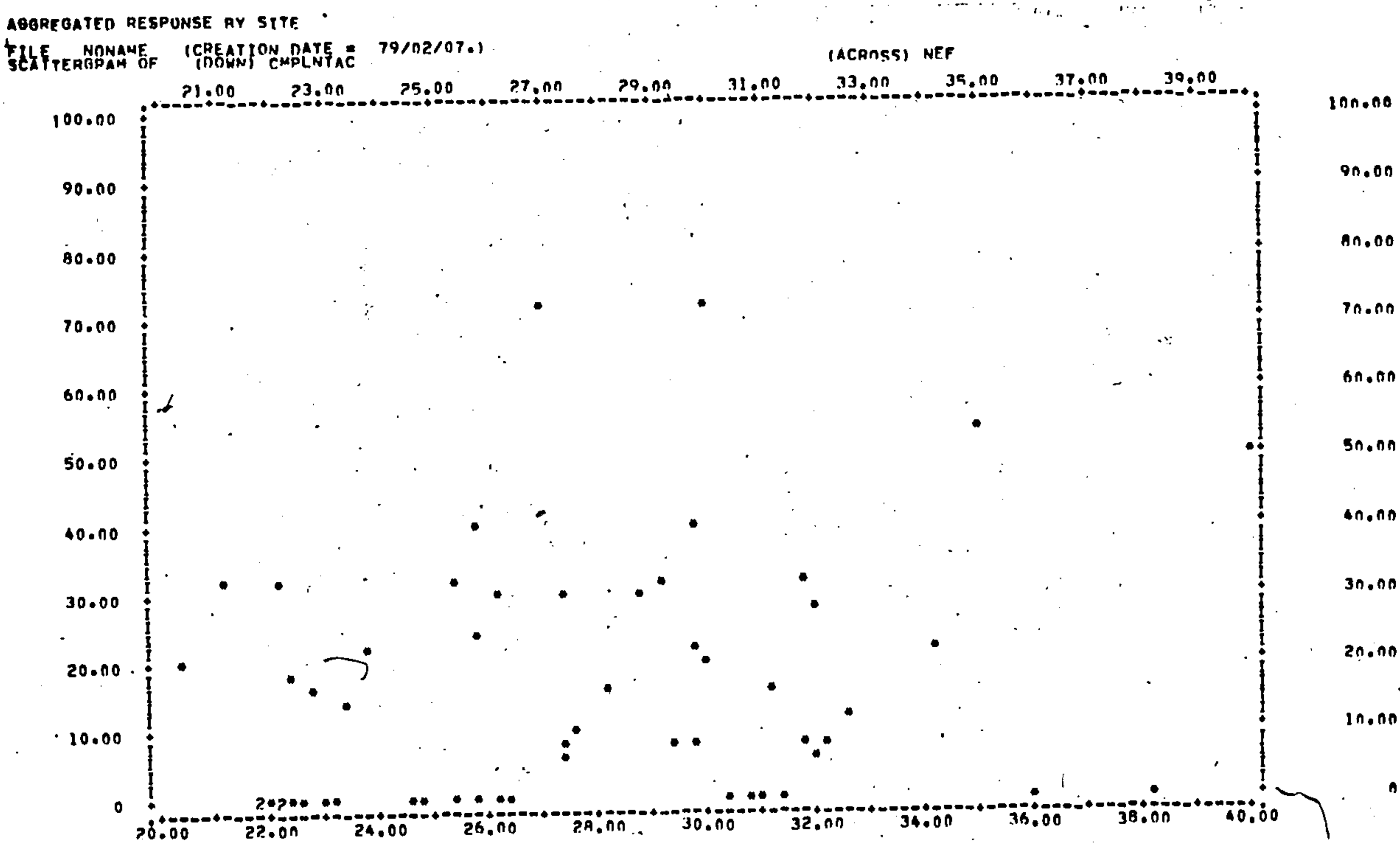


Fig. 4.9: PERCENT COMPLAINTS AGAINST NEF

AGGREGATED RESPONSE BY SITE

FILE NONAME (CREATION DATE = 79/02/07.)
SCATTERGRAM OF (DOWN) CMPLNTAC (ACROSS) ACLEQ

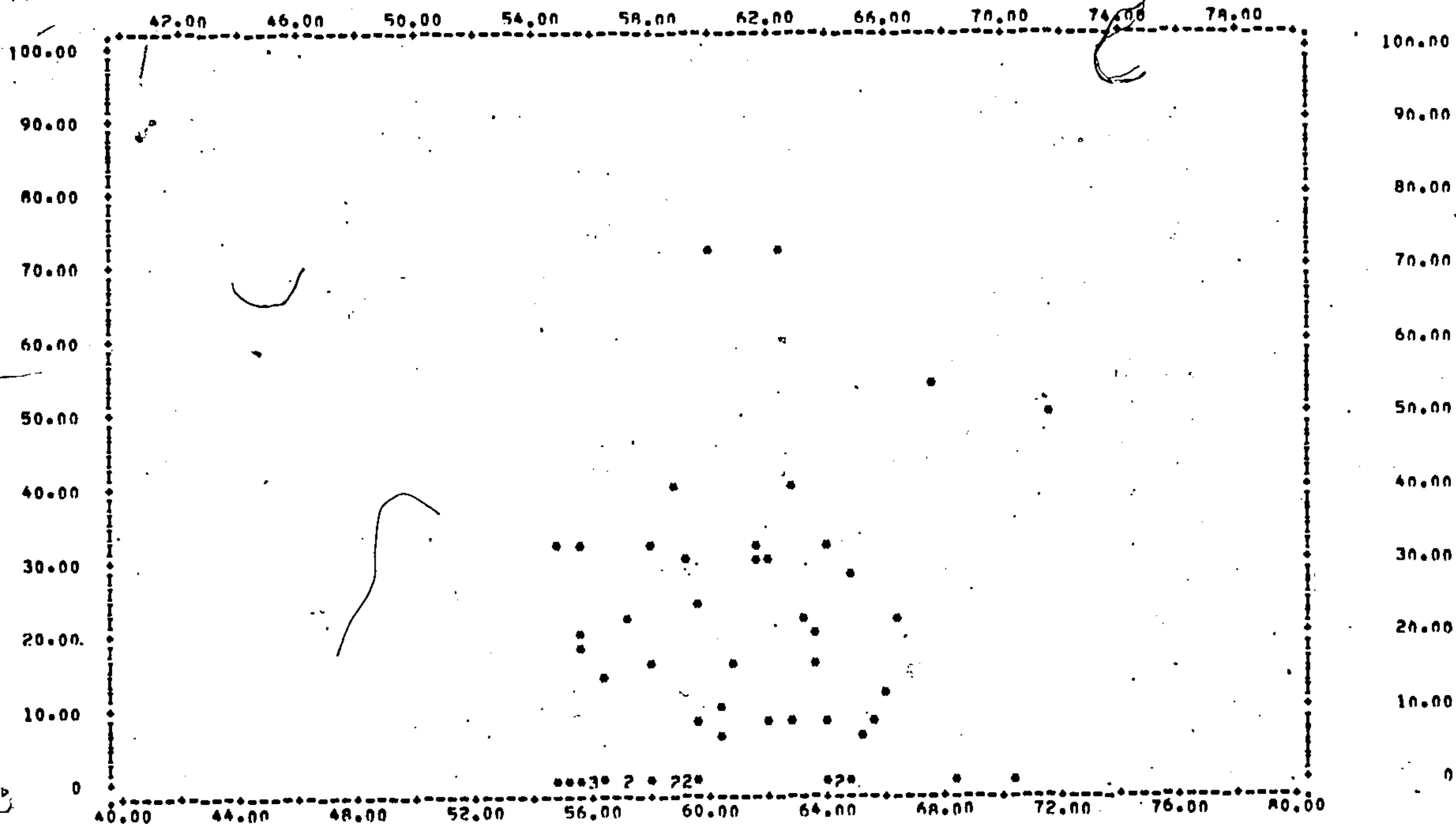


Fig. 4.10: PERCENT COMPLAINTS AGAINST L_{eq}

AGGREGATED RESPONSE BY SITE

FILE NONAME (CREATION DATE = 79/02/07.)
SCATTERGRAM OF (DOWN) CMPLNTAC (ACROSS) ACLDN

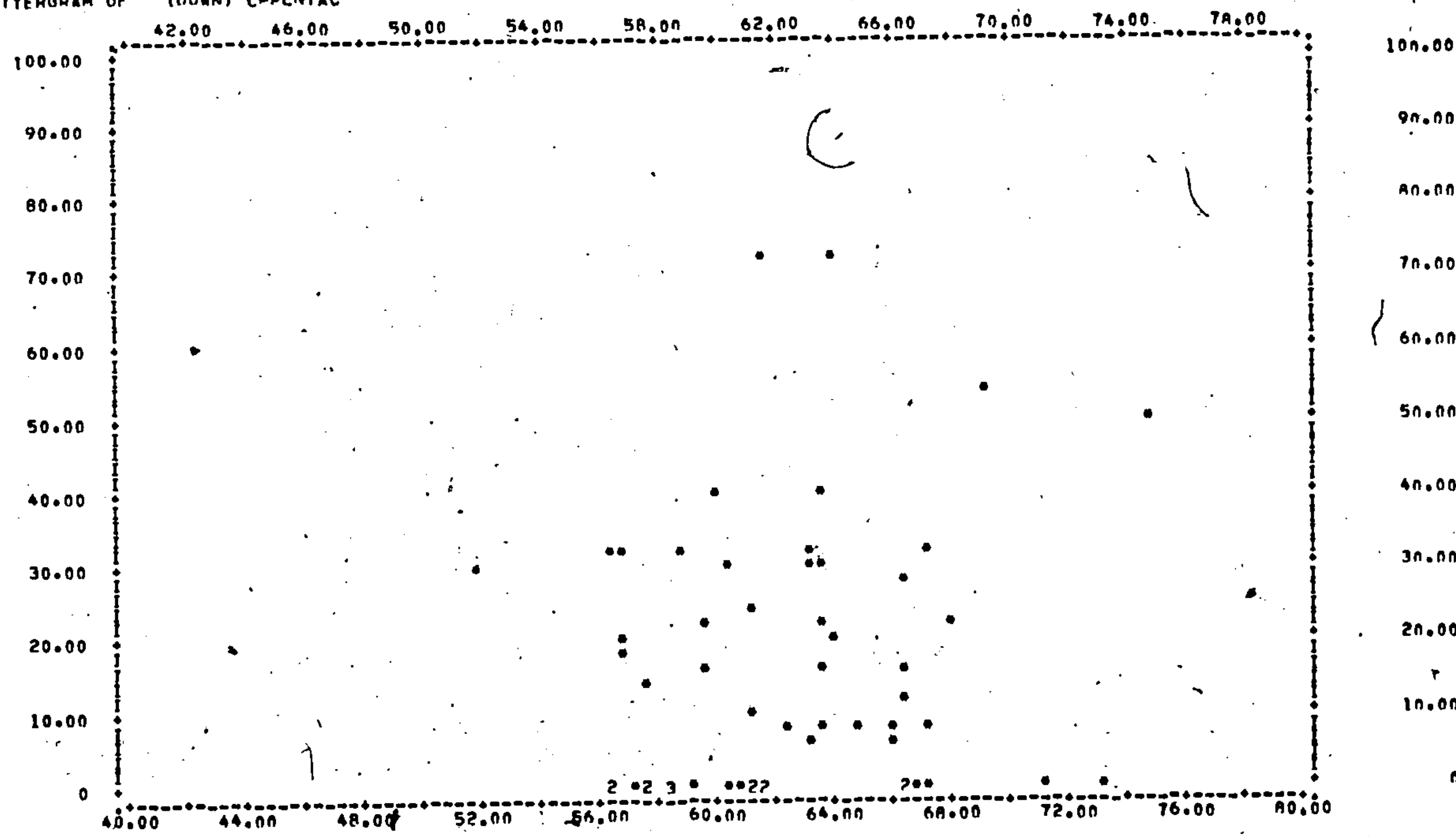


Fig. 4.11: PERCENT COMPLAINTS AGAINST L_{dn}

Percent Highly Annoyed

The statistical coefficents for the three noise descriptors for highly annoyed are represented in Table 4.11.

TABLE 4.11: STATISTICAL COEFFICENTS FOR HIGHLY ANNOYED

	NEF	L_{eq}	L_{dn}
Intercept	- 6.0	-63.4	-42.5
Slope	1.58	1.66	1.28
r	.3438	.3279	.2651
Significance (r)	.004	.006	.024
r^2	.12	.11	.07

The results described "% Highly annoyed" as a function of NEF, L_{eq} and L_{dn} by the following relationships:

$$\% \text{ Highly Annoyed} = -6.0 + 1.58 \text{ NEF} \quad 4.10$$

$$\% \text{ Highly Annoyed} = -63.4 + 1.66 L_{eq} \quad 4.11$$

$$\% \text{ Highly Annoyed} = -42.5 + 1.28 L_{dn} \quad 4.12$$

These relationships predict no people highly annoyed at NEF = 3.79, or L_{eq} = 38.19 dBA, or L_{dn} = 33.2 dBA.

However, from Table 4.11 the coefficient of determination r^2 = .12 means that only 12% of the total variance in the percentage of people reporting highly annoyed is explained by the regression equation 4.10 and only 11% and 7% are explained by the regression equations 4.11 and 4.12.

Table 4.12 shows percent reporting highly annoyed at various noise levels.

TABLE 4.12: % HIGHLY ANNOYED AT VARIOUS NOISE LEVELS

NEF				
NEF	35	30	28	3.92
% Highly Annoyed	49.3	41.4	38.24	0
L_{eq}				
L_{eq}	68	63	61	38.19
% Highly Annoyed	49.43	41.18	37.86	0
L_{dn}				
L_{dn}	71	66	63	33.2
% Highly Annoyed	48.38	41.98	38.14	0

Figures 4.12, 4.13 and 4.14 indicate that a linear fit is as good as any other. From Table 4.11 the correlations between variables are very poor and it is not a good fit. All the three noise descriptors are not significantly different in predicting percent highly annoyed.

AGGREGATED RESPONSE BY SITE

FILE NONAME (CREATION DATE = 79/02/07.)
SCATTERGRAM OF (DOWN) ACINT2 (ACROSS) NEF

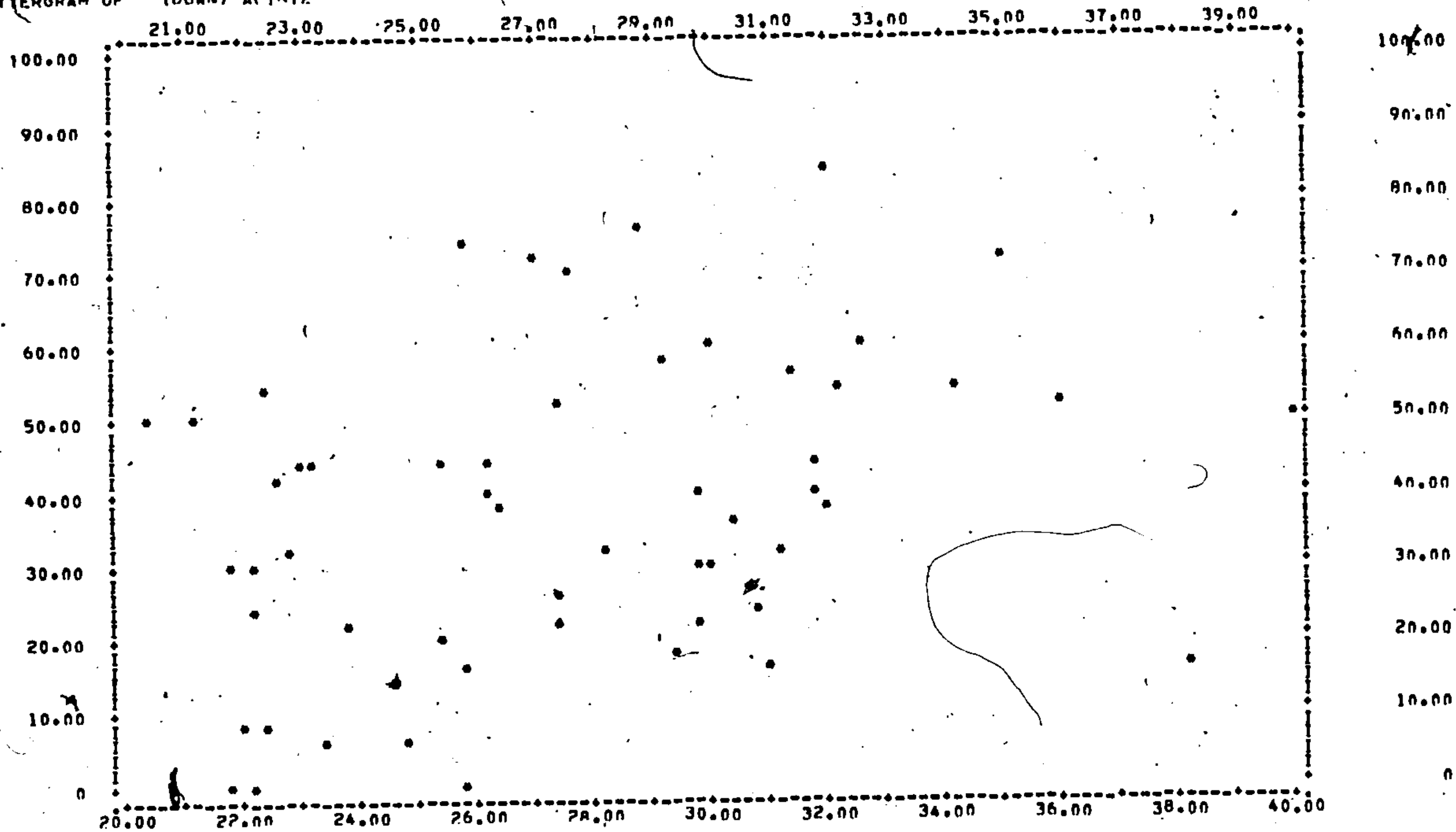


Fig. 4.12: PERCENT HIGHLY ANNOYED AGAINST NEF

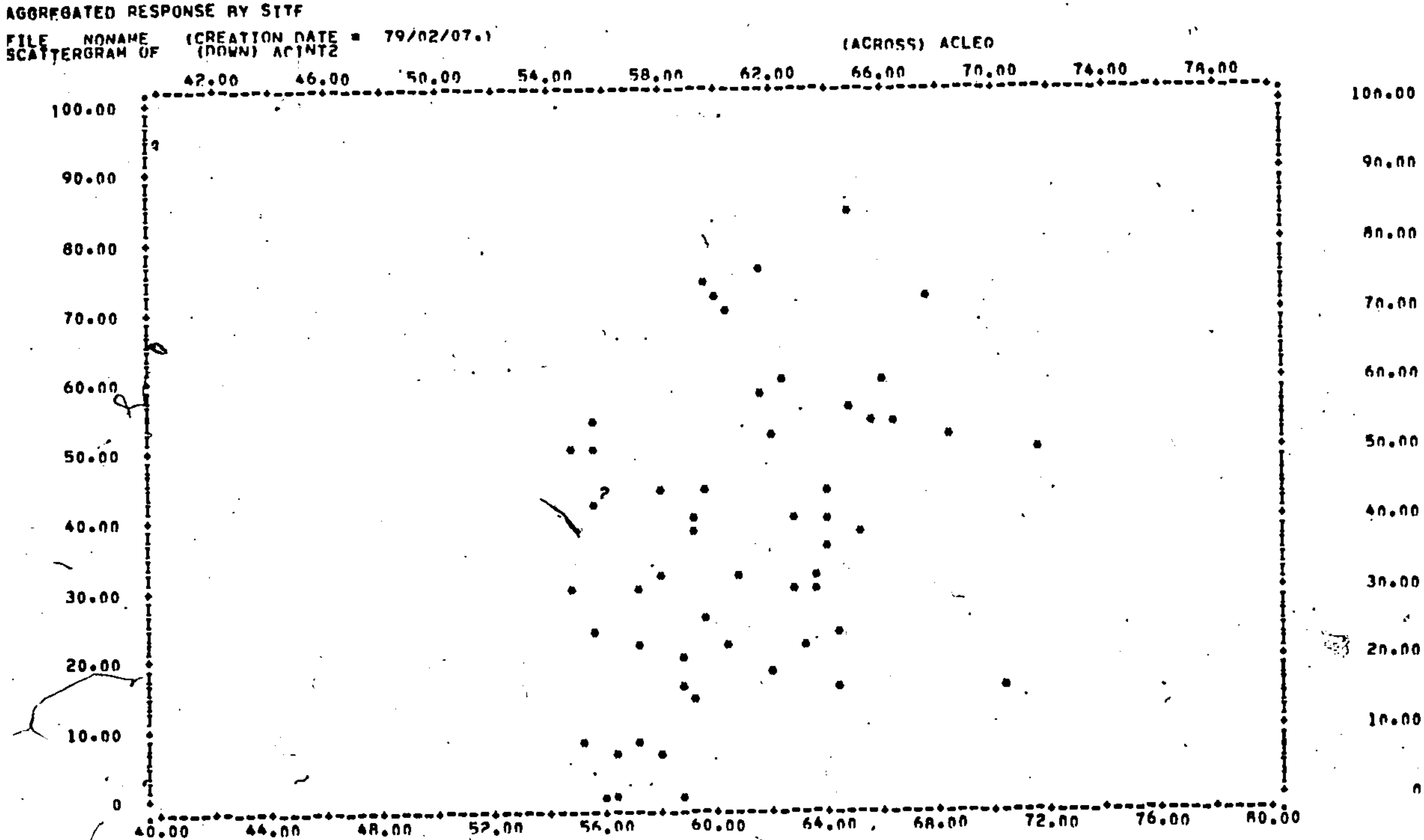


Fig. 4.13: PERCENT HIGHLY ANNOYED AGAINST L_{eq}

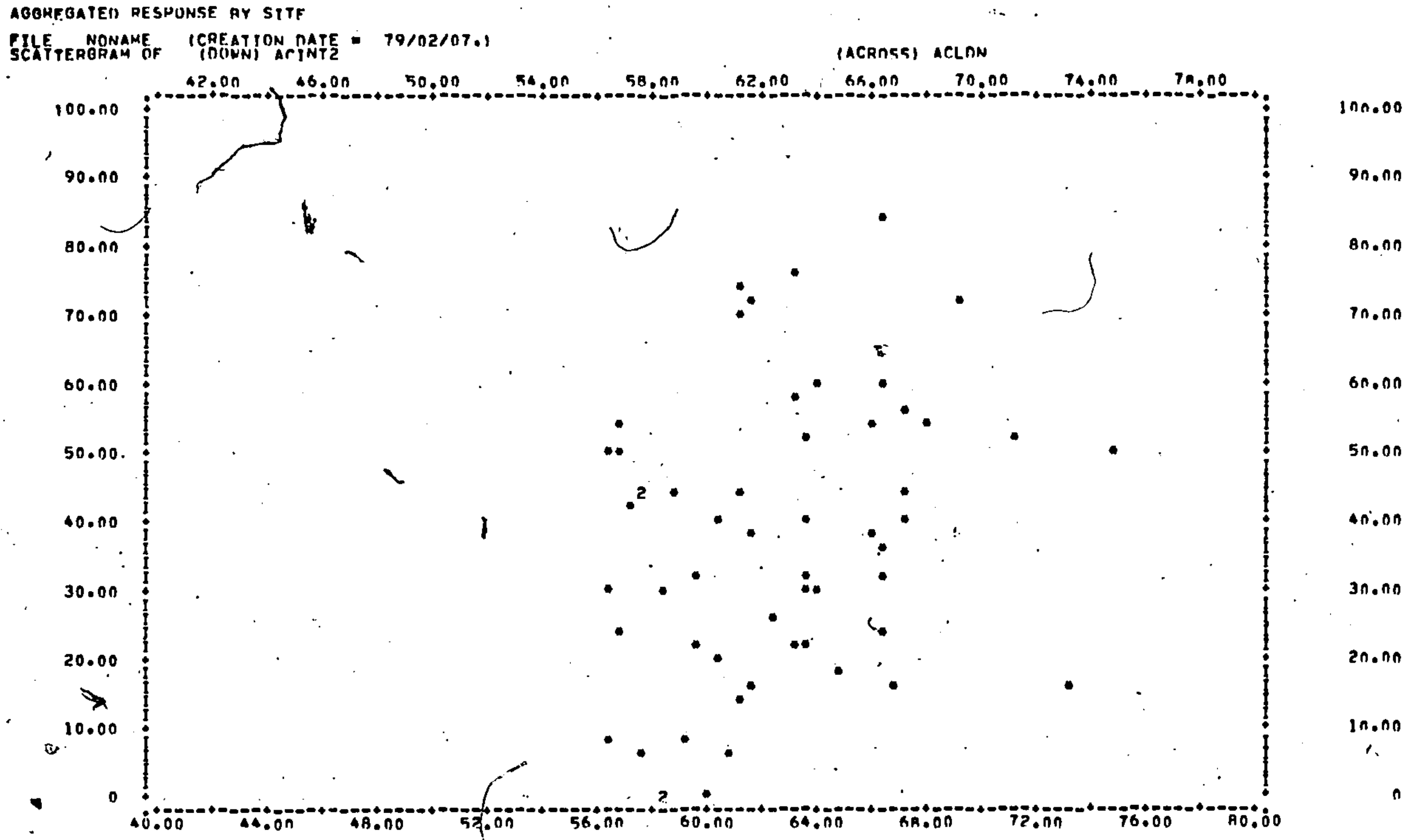


Fig. 4.14: PERCENT HIGHLY ANNOYED AGAINST L_{dn}

4.3 Brief Summary

This section provides a brief summary, Table 4.13 shows the R values of noise metrics for the four variables investigated.

TABLE 4.13: R VALUES OF NOISE METRICS			
	NEF	L_{eq}	L_{dn}
% Speech Interference	.6159	.6089	.5517
% Sleep Interruption	.3784	.3725	.3614
% Complaints	.2200	.1930	.1431
% Highly Annoyed	.3438	.3279	.2651

Linear regression analysis were performed in order to provide the best description of the relationship between the noise metrics and each response variable. The result drawn from the linear regression equation for noise metrics (Table 4.3), that L_{eq}, L_{dn} and NEF are very highly correlated, have been proven by Table 4.13 results. Therefore, the three noise descriptors are equal in predicting percentage of annoyance people experience for each response variable.

CHAPTER 5

CONCLUSION AND RECOMMENDATION FROM RESULTS

The purpose of this thesis was to determine the relative merit of L_{eq} and L_{dn} measuring techniques in comparison with NEF for predicting community reaction to aircraft noise. This is important for at least three reasons:

1. The acceptance of L_{eq} or L_{dn} for predicting community reaction to aircraft noise.
2. It is a necessary step towards standardizing noise measurements.
3. L_{eq} is simpler to calculate than NEF.

The answer to the question which this thesis has dealt with is not obvious. NEF should be a better predictor of community response for the following reasons.

1. It has been developed specifically for aircraft noise measurement.
2. NEF calculations are much more complex, and so should be more accurate.

For these same reasons, one would not expect NEF and L_{eq} to be closely correlated. However, they may be equally good predictors of community response on the basis of different aspects of the aircraft noise.

To answer this question, two kinds of data were needed: Community response data, and noise levels, in terms of the three measures. The response data were derived from a social survey which was conducted in the summer of 1978 (June, July and August) at 56 residential sites in the vicinity of Toronto International Airport. A total of 673 interviews were obtained from households at the 56 sites. This study used the FAA Integrated Noise Model (INM) to calculate aircraft noise measures. The INM is a computer program which predicts the noise of aircraft in the vicinity of an airport in terms of Noise Exposure Forecast (NEF), 24-hour Equivalent Sound Level (L_{eq}), Day-Night Average Sound Level (L_{dn}) and Community Noise Equivalent Level (CNEL) for selected points on the ground (a grid analysis for specific coordinates around an airport) or in terms of contours of equal noise exposure. The INM provided us the physical data in terms of NEF, L_{eq} and L_{dn} for each of the 56 sites (see Table 4.2).

Before turning to the community response data, the noise measures at the 56 sites were compared using correlation and regression analysis.

For the 56 sites, L_{eq}, L_{dn} and NEF are highly correlated. ($r^2 = 0.97$ for L_{eq} and NEF; $r^2 = 0.95$ for L_{dn} and NEF).

This result is somewhat surprising for the reasons discussed in the beginning of this chapter. L_{eq} measuring technique has never been applied to calculate aircraft noise, while NEF is specially developed for this purpose. In addition, NEF calculations are much more complex than L_{eq} calculations. This result suggests that there will be very little difference in the ability of the three measures to predict community response. In order to identify fully the specific relationship between these noise measures and community reaction, however, it was still necessary to proceed with further analyses, although the general trend of the answer to the research question is clear from this result.

Regression analysis was used to identify equations relating four response variables to each of the three noise measures. The response variables were aggregated measures (not individual), based on the percent of people at each site reporting speech interference, sleep interruption, complaints, and high annoyance. Since these percentages were taken over only 12-15 people, a high variation can be expected.

The results show that the three noise descriptors, NEF, L_{eq} and L_{dn} are not significantly different in predicting the percentage of people reporting each of the four responses (Table 5.1). Clearly these R^2 values are not high. One reason is of course, the small number of people (10-12) each percentage was calculated over. A random fluctuation of one person implies ± 10 points in the percentage responding, which is nearly half the scatter in the graphs (for example Figs. 4.4, 4.7, 4.10 and 4.13). These small numbers at each site were necessary for other purposes of data collection, and were beyond the control of this thesis. Another possible reason for the low R^2 values may have to do with the INM calculation.

INM calculated NEF values do not agree exactly with NEF values calculated by Transport Canada's computer program. However, INM was the only way to obtain all three noise measures in one program. Other studies have shown each metric taken separately, to be good predictors of community response, so these results (Table 5.1)should not be taken as showing that all are poor predictors.

TABLE 5.1
PREDICTIVE ABILITY (R^2) OF NOISE METRICS

	L_{eq}	L_{dn}	NEF
% Highly Annoyed	.12	.11	.07
% Speech Interference	.37	.30	.38
% Sleep Interruption	.14	.13	.14
% Complaints	.05	.04	.02

Given this result, that all three metrics are equally good, this study recommends the use of L_{eq} for aircraft noise because it is used for evaluating noise sources other than aircraft. It would be more convenient if L_{eq} could be used for evaluating aircraft noise also.

In addition, L_{eq} does not apply any night penalty. Both NEF and L_{dn} apply a 10 dB penalty for aircraft arriving or departing an airport after 22:00 hours, but not a minute earlier (21:59 hours). In other words, the two reasons for the importance of this research question form the basis for the argument for preferring L_{eq}.

Many noise exposure indices are used internationally to evaluate aircraft noise. These are basically similar to each other. For example, the International Civil Aviation Organization uses WECPNL (Weighted Equivalent Continuous Perceived Noise Level); in South Africa they use NI (Noisiness); in The Netherlands they use B (Total Noise Load); in France they use N (Isopsophic Index); in U.K. they use NNI (Noise Number Index); in U.S.A. they use NEF, CNR and CNEL. In Canada they use NEF only. Table 5.2 provides us with a comparison of all the above noise indices (Ref. 13).

TABLE 5.2

Equations for comparison of noise exposure indices	
USA:	$CNR = 10 \log_{10} 10^{L_{pn}/10} + 10 \log_{10} N - 12$
	$NEF = 10 \log_{10} 10^{L_{epn}/10} + 10 \log_{10} N - 88$
France:	$N = 10 \log_{10} 10^{L_{pn}/10} + 10 \log_{10} N - 30$
Great Britain:	$NNI = 10 \log_{10} 10^{L_{pn}/10} + 15 \log N - 80$
Germany:	$Q = 13{\cdot}3 \log_{10} 10^{L_{pn}/13{\cdot}3} + 13{\cdot}3 \log_{10} N - 52{\cdot}3$
South Africa:	$NI = 10 \log_{10} 10^{\frac{L_{pn}-13}{10}} + 10 \log_{10} N - 39{\cdot}4$
Netherlands:	$B = 20 \log_{10} 10^{\frac{L_{pn}-13}{15}} + 20 \log_{10} N - C$
ICAO:	$WECPNL = 10 \log_{10} 10^{L_{epn}/10} + 10 \log_{10} N - 39{\cdot}4$

Note: L_{pn} = *PNdB* and L_{epn} = *EPNdB*
N = Number of events heard.

Source: "The Economic Value of Peace and Quiet"
Starkie, D.M., Johnson, D.M:

The wide range of descriptive indices is for political reasons rather than purely technical ones. The results of this thesis suggest that this wide range of descriptive indices in current use is unnecessary and may, in fact, hinder technical understanding of aircraft noise effects.

APPENDIX 1

Transport Canada Statistics, 1977 Operations of Toronto International Airport

TORONTO INTERNATIONAL AIRPORT

TABLE 1 ARRIVALS

DC-9-32

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L						1	15	31	41	28	40	54	47	65	16	42	36	43	34	50	67	12		
05R	2				1	7	45	111	146	106	94	72	52	70	70	131	154	129	63	105	142	75	115	11
14L	4	2		1		4	46	99	109	99	96	109	85	122	65	84	85	70	59	77	101	102	137	15
23L		1				3	45	89	104	99	105	123	104	197	118	244	240	193	152	169	204	57	20	2
23R						1	22	36	32	27	23	43	42	41	244	48	83	90	52	72	46	10	2	
32R							3	24	53	40	63	78	64	128	48	112	107	79	59	38	9	5	2	
Tot.																								

B727-200

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L						1	12	22	5	19	9	22	9	15	10	10	9	21	20	11	35	21		
05R		1				2	22	81	33	56	25	33	8	20	32	28	31	63	40	32	69	83	57	6
14L	2	2				1	31	72	30	43	19	41	15	29	39	17	15	40	29	20	45	92		8
23L						1	32	63	23	57	31	54	17	48	80	40	51	106	66	50	101	54		
23R							16	19	9	13	15	20	6	8	13	13	21	39	34	23	18	11		
32R							6	18	18	16	26	25	11	31	43	19	26	38	29	11	6	4		
Tot.																								

B707-120B

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L						4	14	10	15	2	15	16	20	15	19	12	12	10	26	18	23	3		
05R	9	3			1	4	66	33	43	8	12	19	23	19	59	41	28	55	36	33	45	64	31	32
14L	11	1		1		15	44	31	40	11	20	35	43	12	54	31	15	26	23	28	37	73	40	43
23L	1					5	46	25	31	11	22	36	43	66	99	67	64	59	77	68	67	39	8	3
23R				1		5	16	16	11	4	5	6	17	9	26	17	27	28	26	22	8	8	3	
32R				1			1	3	14	8	10	27	27	32	55	31	24	25	30	9	5	2		
Tot.																								

B707-120/320

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L											2		1						3	1	2			
05R	1					3	2	2	3	2	2	4	8	2	11	9			3	3	3	1	2	
14L	1							2	2				3		12	2	6	1	3	3	5	2	1	2
23L							6	2	5	1	2	[illegible]	1	6	9	6	8	5	10	8	6	1	3	1
23R								1	2	1	3	2	3		3	4	2		4	2	2			
32R						3	2	1	1		2	6	2		10	2	4	6	2	2				1

ARRIVALS TABLE 1 (Continued) TORONTO INTERNATIONAL AIRPORT

DC-10-10

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L								9	20		2		6	19	5	6	7	16	5	37	29	5	1	
05R	4	2	1	/	1	3	4	20	77	9	5	4	6	19	23	32	15	59	9	66	55	30	14	4
14L	4	4			3			23	71	5	1		5	39	14	21	13	40	15	46	54	39	26	7
23L						1	5	20	74	8	2	3	16	49	40	64	34	87	24	106	91	35	7	2
23R								4	29	1	1	1	3	11	4	13	11	40	12	38	24	6		
32R					1			9	30	5	3	3	4	30	23	23	16	35	13	26	5			
Tot.																								

B747-200

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L									2				1	7	4	11	8	7	7	7	10			
05R	3		1	1		1	2		4	1		1	3	8	17	39	29	19	8	14	16	2	2	3
14L	6	4		1	1				5		1	1	4	23	11	23	17	12	14	10	16	9	6	1
23L						1	1		5	1			7	25	19	59	41	26	32	30	22	6	2	
23R						1	1		1			1	1	5	3	17	18	13	12	16	6	4	1	
32R			1						2	2			1	11	19	33	12	12	8	5		1	1	
Tot.																								

SABRELINER

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L	2	1		1	1	1	5	12	17	20	13	20	12	25	19	27	25	25	31	26	20	14	17	5
05R	3	4	2	3			6	15	25	15	7	3	6	6	9	13	10	10	11	3	9	8	4	4
14L	5	3	2	1		1	5	23	34	19	18	26	24	22	27	21	11	11	18	16	22	13	11	9
23L							2	9	10	8	5	10	7	7	9	14	17	17	10	19	7	3	2	1
23R	1						6	24	20	16	19	29	30	22	42	63	77	77	54	43	17	13	3	1
32R							2	12	18	20	16	20	24	21	28	24	33	33	26	23	1	1		
Tot.																								

TWIN OTTER

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L	2	1	1				8	17	10	13	9	13	16	20	9	20	26	24	23	11	11	8	7	4
05R	1				2	3	28	49	45	10	6	12	16	13	7	21	29	28	19	18	14	18		4
14L	3	1	1	h		1	28	45	32	18	9	24	19	14	27	13	19	18	23	11	16	18	14	5
23L	1		1				25	41	27	8	11	20	24	24	18	24	59	52	40	29	17	17		2
23R							12	25	17	14	16	23	14	23	25	37	53	42	37	20	15	4	3	4
32R	3					1	6	23	27	13	15	10	25	38	18	24	29	39	13	2	4	1	1	3

CESSNA 310 ARRIVALS Table 1 (continued) TORONTO INTERNATIONAL

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L	11	7	2	4	2	1	12	35	60	72	54	67	57	62	58	75	99	105	64	114	82	77	47	12
05R	16	15	12	12	8	9	5	24	14	8	4	8	2	6	7	5	11	24	4	12	4	6	24	23
14L	11	4		2	4	5	6	28	25	38	36	40	31	26	14	16	20	16	14	12	12	30	42	23
23L	6	5	2	3	1	3	5	9	7	13	2	4	4	2	13	9	8	40	10	10	3	6	5	6
23R	30	6	6	2	2	5	10	30	32	48	74	64	72	72	88	98	131	124	93	111	82	56	21	14
32R	19	4	6	7	8	3	6	28	42	56	63	51	38	48	41	28	34	44	16	11	11	4	15	19
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

DC-9-32 TABLE 2 DEPARTURES

0 - 500 MILES TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	
05L							2	6	6	4	1	3			4	5	16	23	15	6	2				93
05R								59	41	21	47	30	68	67	21	22	40	29	55	23	22	16			582
14L								3	4	3	3			1		1	1		2			3			21
23L					1		233	161	71	62	109	81	135	149	98	74	167	120	153	61	56	73	47	12	1863
23R						1	157	131	61	44	113	56	107	161	120	139	222	130	193	90	72	43	2	1	1843
32R	2					2	196	174	85	87	135	75	135	174	142	124	207	149	146	74	56	66	42	10	2081
Tot.																									6483

501 - 1000 MILES

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	
05L									3						1	5		1	2	1					13
05R							1	2	9	2		3		1	8	10	2		13	4	5	3			63
14L									1	1		1		1			1								5
23L							5	11	42	6	12	3	1	2	38	23	2	2	34	9	7	45	22	1	265
23R							3	8	26	1	11	3	1	3	34	46	5	1	35	12	9	12	2		212
32R							5	11	41	6	9	2	1	4	60	38	2	2	31	10	8	41	16	1	288
Tot.																									846

1001 - 1500 MILES

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	
05L										1															1
05R							2	1		10	3	1			3		1	1	2	5	4				33
14L										2		1						1			2	2			8
23L							3	5	2	30	10	5	1	2	2	1	1	1	3	5	10	6	2	1	90
23R							3	8		23	3	10	1		3	3	3	6	7	9	20	4	2		105
32R							4	6	4	40	12	4	1		4	2	2	10	10	17	13	7	2		138
Tot.																									375

1501 - 2500 MILES

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	
05L																									
05R							1																		1
14L																									
23L								1			2	1		1	1	1			1						9
23R								3			3								4						10
32R								2	1		7								1			1			32

DC-9-32 TABLE 2 (Cont'd.) DEPARTURES 2501 - 3500 MILES TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																		1						
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

3501 - 4500 MILES

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																					1			
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

B727-200 TABLE 2 (Cont'd.) DEPARTURES (0-500 Miles) TORONTO INTERNATIONAL AIRPORT

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L		1					1	4	4	2	1				3		8	4	5	8	2			
05R							15	21	22	10	19	20	10	24	8	14	10	5	22	32	5	21	1	
14L								2			3				1							1		
23L	1					1	55	78	71	36	55	43	28	42	24	57	34	22	55	84	33	38	14	9
23R							44	55	58	35	48	46	19	46	42	80	48	32	72	80	43	35	4	
32R	1						57	74	97	57	70	48	25	50	45	76	51	25	62	70	26	43	14	3
Tot.																								

(501-1000 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L										1														
05R									6	1	4													
14L																								
23L									23	6	12				1	2		1			1		2	
23R									20	1	10			1		1								
32R									28	3	10			1		1							1	
Tot.																								

(1001-1500 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L									2	1														
05R									12	1	6	1		2							1	2		
14L																								
23L							1	1	40	9	14	2	1									3	4	
23R								1	34	2	18	2									1	5		
32R								2	52	7	17	3		1						1		2	6	
Tot.																								

(1501-2500 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																					1			
14L								1																
23L										1														1
23R										5					1				1					
32R								1		2						1			2					

B727-200 TABLE 2 (Cont'd.) DEPARTURES (2501-3500 Miles) TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																			1					
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

B707-120B (0-500 Miles) DEPARTURES Table 2 (continued) TORONTO INTERNATIONAL

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L									3	1								9		4	1			
05R							25	6	3	6	2	5	1	6	2	8	6	4	5	11	8	2		
14L							1	1		2	1					1						1		
23L							98	15	8	27	4	6	4	4	15	8	22	24	12	9	12	23	33	
23R							61	16	6	18	7	4	10	02	18	26	18	30	14	16	26	10	2	
32R							87	14	8	29	8	4	6	6	24	20	23	27	11	12	15	12	23	
Tot.																								

(500-1000 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																	1	2						
05R								1		7	3	2		2	2	1	5			1				
14L											1													
23L	11	2					4	1		22	11	5		12	8	7	19	3	3	3	3		13	5
23R										20	15	8		15	6	5	25	3	1	1	1		1	1
32R	34	8					3	2	3	26	21	4	2	17	11	12	22	3		2	3	19	10	
Tot.																								

(1001-1500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L								1							1			2		2				
05R								7	2		1	3		7				1	6	3		1		
14L									1					1						1				
23L								26	20	4	4	4	4	15	4	1	2	15	13	12	2	1	1	
23R								13	8	2	1	7		17	2	1	5	8	16	22	1	3	1	
32R								24	7	5	1	2		22	4	1	2	12	9	14				
Tot.																								

(1501-2500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L									2	1	1								2	1				
05R							2	2	11	3	1	5	10	1	1		1		9	8				
14L									2															
23L						1	10	10	35	12	5	15	7	2		1	2	2	12	10	4	6	2	3
23R						1	2	5	26	11	5	13	7	2	2	1	2	3	18	11	5	5	1	
32R							7	3	49	7	2	17	7	4			1	1	14	7	2	2	4	1

B707-120B (2501-3500 Miles) DEPARTURES Table 2 (continued) TORONTO INTERNATIONAL

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																		2	1	1	1			
05R									4								1	2	2	6	7	3		
14L		1							1					1	1		3		8	12	8	12	2	
23L		1			1				4	2	1		1				2	6	4	11	18	12	9	2
23R		1						1	5		1			1		2	2	6	18	30	30	16	6	
32R	4	3			1				7	2	2			1			8	7	11	21	22	27	21	7
Tot.																								

(3501-4500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L									1															
05R														1							2			
14L										2				2	1	3		3		2	8	10	1	
23L									1		1		1	1				2	1	2	3	1	1	1
23R									2		1			3			2	1		5	3	3	2	1
32R	1									2	2	2	4	5	2	5	1	9	1	4	4	12	5	2
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

B707-120/320 TABLE 2 (Cont'd.) DEPARTURES (0-500 Miles) TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R								1		1								1	1					
14L																				1				
23L						1	3	1		1	1	1			1	5	1	6	3	5	2	1	3	
23R							6	3		1					2	4	1	3	1	1	2	1	2	
32R							9	1		5		1	1	1	4	1		10	2	1	1	3		
Tot.																								

(501-1000 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R												1												
14L																								
23L							1			2		1		3		2	1	1					1	1
23R										2	3	1		2	1	1	3							
32R	6	2								8	4	3		2	1	3	5		1				4	1
Tot.																								

(1001-1500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R									1					1										
14L																								
23L									3		1			1			1		2	1				
23R								4		2				3					1	2				
32R							1	2	3					4				1		1				
Tot.																								

(1501-2500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R									1	1	1								1					
14L																								
23L							1					5	4		1				7	1				
23R									3			2	1	1	1					4	2			
32R									6	1		3	2	1					6	1				

B707-120/320 TABLE 2 (Continued) DEPARTURES (2501-3500 Miles) TORONTO INTERNATIONAL AIRPORT

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																						1		
05R																			1		1	1		
14L																	1			3	1	2	1	
23L																		1	4	3	4	1	1	
23R																		3	3	3	2	7	1	
32R																								
Tot.																								

(3501-4500 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																					2		1	
23L														1										
23R																							1	
32R												1						1			1	3	1	
Tot.																								

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

DC-10-10 TABLE 2 (Continued) DEPARTURES (0-500 Miles Range) TORONTO INTERNATIONAL AIRPORT

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L										1					1		1			4				
05R							11	2	8	2	12	1			6	2	5	3	3	10	8	3		
14L											1				1					1				
23L		1					43	12	17	9	14	3		1	21		17	9	10	36	24	41	11	3
23R							33	9	14	8	8	2			20	1	25	8	5	42	21	12	2	
32R						1	36	6	24	12	24	6			28	6	24	18	7	29	23	26	12	
Tot.																								

(501-1000 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																1	1							
05R							1					11				4		1	4		6			
14L											2					1								
23L							5	3			6	22	1		1	14	1	1	2	4	9	7	5	
23R							1				6	18				22		1	1	10	14	9		
32R							5	2			8	16	2		1	19	2		3	8	7	7	2	
Tot.																								

(1001-1500 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L											1									2	1			
05R										7	6								4	11	2			
14L										1										1				
23L								3		18	22	2	1	3	1	1			7	28	5	5	4	
23R								1		16	27	4		5		3			8	33	3	4		
32R								2	1	27	34	2	1	1	1				12	22	3	5	2	
Tot.																								

(1501-2500 Miles)

Time / Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L										1										2				
05R										18									6	3	1	2		
14L																			1					
23L									4	61	8	3	1			1			13	9	3	5	2	
23R										54	5	1		1	1	1			15	7	2	9		
32R									3	83	4	1	1						14	5	1	5	2	

DC-10-10 TABLE 2 (Ctoninued) DEPARTURES (2501-3501 Miles) TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																		2		4				
05R																		1	1	3	2			
14L							1											1		10	1	3		
23L								1	1			1		1				6	4	16	8	5	1	
23R		1					2		1									7	5	16	10	6	1	1
32R		1	2	1												1		10	7	30	3	10	1	
Tot.																								

(3501-4500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																		3						
05R																		3	1					
14L																		3	1	1		1		
23L											1							10	3	1				
23R									1	1								15	2	2	1		1	
32R																		13	1	2				
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

B747-200 TABLE 2 (Continued) DEPARTURES (0-500 Miles) TORONTO INTERNATIONAL AIRPORT)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																			2					
05R											2						1	2	4	2	1			
14L													1								1	1		
23L											2	1					2	10	6	1	5	1		1
23R											5	2					1	6	10	4	4	1		
32R									1		5	1			1			12	9	4	4			
Tot.																								

(501-1000 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R															1									
14L																								
23L																								
23R																								
32R																								
Tot.																								

(1001-1500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L									1											1				
23R																								
32R									1				2											
Tot.																								

(1501-2500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																			2	1				
05R									5	1									9	4	1	1		
14L																								
23L			1						20	4	2		1						15	11	5	3	1	2
23R									17	5	1						1		19	9	5	1		
32R							1		27	5									22	8	2		1	

B747-200 TABLE 2 (Continued) DEPARTURES (2501-3500 Miles) TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																		1	1	4				
05R																		1	3	6	15	3		
14L																			5	7	2	6		
23L	1	2	1				1					1	1	1				4	17	23	22	28	7	4
23R	1						2			1				1				5	20	34	48	16	5	2
32R	3	6	3		1						2		1				1	6	24	40	39	23	11	9
Tot.																								

(3501-4500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																		2	1					
05R																		2	2		1			
14L																		7	1					
23L																				1	[illegible]	1	2	2
23R																		6	3	4	1	1		
32R																		11	2	2		1		
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

SABRELINER TABLE 2 (cont'd.) DEPARTURES (0-500 Miles) TORONTO INTERNATIONAL AIRPORT

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L							36	32	17	13	9	7	19	10	10	7	21	18	8	8	6	4		1
05R									1			1						1		1				
14L							25	41	20	12	15	20	26	36	32	24	19	9	8	6	5	8	2	
23L	1						1	1		1	2	2	1		2	2	2					1		
23R	1	1	1		5	14	59	59	41	34	34	27	36	52	69	77	71	48	30	20	17	9	5	1
32R	1	1	1	1		12	27	57	50	37	24	32	37	45	50	50	34	44	9	11	11	9	2	
Tot.																								

TWIN OTTER (0-500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L	1				2	2	11	17	17	8	7	4	12	4	2	18	14	9	6	3	5	1	4	1
05R							2	12	6	1	1	11	2	4	11	1	7	8	9	1	8	1		
14L						5	17	12	14	11	14	8	9	9	18	11	7	6	7	3	3	3		
23L			1				8	46	26	12	4	28	3	10	34	1	23	36	24	10	22	42	10	3
23R						13	19	56	34	50	22	33	26	41	86	34	54	70	37	28	35	22	4	
32R	6	1				5	20	75	53	46	21	46	24	36	85	25	43	68	32	22	21	34	11	
Tot.																								

CESSENA 310 (0-500 Miles)

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L	18	32	8	7	8	18	50	46	71	42	48	48	47	51	47	59	43	35	45	34	24	20	44	13
05R	1				1				8	1	1				1			1	6		2		2	
14L	14	38	7	9	7	15	34	48	49	50	35	38	58	41	42	29	19	24	24	21	18	22	24	7
23L	2	4	1	2	3	1	3		8	1		1		2		3		1	21	2		24	8	2
23R	2	11	4		8	58	50	89	91	93	97	86	83	102	98	165	111	83	113	70	45	25	19	9
32R	8	12	8	1	2	7	40	58	121	75	64	50	71	50	79	55	46	37	42	17	6	32	26	11
Tot.																								

Time Rwy.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
05L																								
05R																								
14L																								
23L																								
23R																								
32R																								

APPENDIX 2

Social Survey Questionnaire

SAMPLE CELL ________________ (1-2)

BLOCK CODE ________________ (3-5)

ADDRESS ________________ (6-9)

INTERVIEWER # ________________ (1/10)

START TIME ________________ (1/11-14)

NEIGHBOURHOOD ATTITUDE SURVEY

McMASTER UNIVERSITY

TRANSPORTATION RESEARCH GROUP

CALL	DATE	TIME	RESPONSE
1.	________	________	________
2.	________	________	________
3.	________	________	________

INTRODUCTION: Hello, I'm from the Geography Department at McMaster University in Hamilton. I'm interviewing people to find out their opinions about their neighbourhood. Could you spare me about 10 minutes? Thanks very much.

1a. What are the important things you like about living in this neighbourhood?

[√ *all items mentioned in column "Like V"*]

b. What the important things you don't like about living in this neighbourhood?

[√ *all items mentioned in column "Don't like V"*]

c. [*Use CARD A*]

Here are some other things that have been mentioned. Are any of them important to you as things you like or don't like about this neighbourhood?

[√ *all items mentioned in column "Like E" or "Don't like E"*]

Item	Like V (1)	Like E (2)	Don't Like V (3)	Don't Like E (4)	
Schools	___	___	___	___	
Shopping	___	___	___	___	
Open Space	___	___	___	___	
Recreational Facs.	___	___	___	___	
Bus Service	___	___	___	___	
Proximity to Work	___	___	___	___	(1/15)
Noise	___	___	___	___	(1/16)
Quietness	___	___	___	___	
Air Quality	___	___	___	___	
Landscaping	___	___	___	___	
Cost of Housing	___	___	___	___	
Quality of Housing	___	___	___	___	
Neighbours	___	___	___	___	
Safety for Children	___	___	___	___	
Crime	___	___	___	___	
Maintenance	___	___	___	___	
Privacy	___	___	___	___	
Parking	___	___	___	___	
Other (specify)	___	___	___	___	

d. [*Use CARD B*]

In general, how satisfied are you with this neighbourhood as a place to live.

(1) extremely satisfied ___
(2) considerably satisfied ___
(3) moderately satisfied ___
(4) slightly satisfied ___
(5) neutral ___
(6) slightly dissatisfied ___
(7) moderately dissatisfied ___
(8) considerably dissatisfied ___
(9) extremely dissatisfied ___

(1/17)

e. If you could change just one thing about this neighbourhood, what would it be?

______________________________ (1/18)

[You have mentioned quietness/noise; I'd like to ask you more about that.]

OR

[One of the things we're particularly interested in is the sounds people notice and I'd like to ask you about that.]

2a. What sounds do you notice when you are at home?

[✓ all sources mentioned in column V]

[If road traffic noise is volunteered, ask whether main road or local]

b. *[Use CARD C]*

How do you rate each of the sounds you have mentioned?

[Enter EA-ED rating in column INTENS.]

1 = Extremely Agreeable	6 = Slightly Disturbing
2 = Considerably Agreeable	7 = Moderately Disturbing
3 = Moderately Agreeable	8 = Considerably Disturbing
4 = Slightly Agreeable	9 = Extremely Disturbing
5 = Neutral	

c. *[Use CARD D]*

Here is a list of common sounds (you have already mentioned some). Do you ever notice any of these (any of the others)?

[✓ all sources mentioned in column E]

d. *[Use CARD C]*

How do you rate each of those additional sounds you have mentioned?

[Enter EA-ED rating in column INTENS.]

e. Considering all you have mentioned, how would you rate the overall noise?

[Enter EA-ED rating in column INTENS.]

4

Source	V (1)	E (2)	Intens. (EA-ED)	
Children/other people	___	___	___	
Handyman tools	___	___	___	
Air conditioner	___	___	___	
Domestic pets	___	___	___	
Garden machinery	___	___	___	
TV/radio/records	___	___	___	
Musical instruments	___	___	___	
Local traffic noise	___	___	___	
Main road traffic noise	___	___	___	(4/10-11)
Motorcycles	___	___	___	
Trucks	___	___	___	(5/10-11)
Snowmobiles	___	___	___	
Mini-bikes	___	___	___	
Trains	___	___	___	(6/10-11)
Aircraft	___	___	___	(3/10-11)
Industrial noise	___	___	___	(7/10-11)
Construction noise	___	___	___	
Institutional noise	___	___	___	
Mechanical or plumbing noise	___	___	___	
Other (specify)	___	___	___	
NEIGHBOURHOOD			___	(1/19)

[I would like to ask you more about your reactions to (aircraft/main road/ truck/train/industrial) noise and the overall ~~neighbourhood~~ noise]

3. [*Use CARD E*]

a. On this scale from 0 (not at all disturbed) to 10 (unbearably disturbed) how do you rate (source) noise and the overall noise:

[*Enter 0 to 10 rating in relevant source columns*]

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY	NEIGHBOURHOOD
indoors day	___	___	___	___	___	___
outdoors day	___	___	___	___	___	___
indoors evening	___	___	___	___	___	___
outdoors evening	___	___	___	___	___	___
night	___	___	___	___	___	___
in general	___	___	___	___	___	___
	(3/12-29)	(4/12-29)	(5/12-29)	(6/12-29)	(7/12-29)	(1/20-37)

b. [*Ask only at Malton*]

On the same scale how do you rate (source) noise and the overall _ noise when:

[*Enter 0 to 10 ratings in relevant source columns*]

	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY	NEIGHBOURHOOD
flight path in this direction	___	___	___	___	___
flight path not in this direction	___	___	___	___	___
	(4/30-35)	(5/30-35)	(6/30-35)	(7/30-35)	(1/38-43)

[*Omit Q's 4, 5, 9, 10 for sources with* <u>*all zero*</u> *ratings in 3a. and 3b.*]

4. [*For each* <u>*disturbing*</u> *source only*]

How often does (source) noise disturb you?

[*Read Categories*]

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
(1) less than once a day	___	___	___	___	___
(2) once or twice a day	___	___	___	___	___
(3) several times a day	___	___	___	___	___
(4) almost continuously					
	(3/30)	(4/36)	(5/36)	(6/36)	(7/36)

5. [*For each* <u>*disturbing*</u> *source only*]

a. What time of year are you disturbed most by (source) noise?

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
(1) Summer	___	___	___	___	___
(2) Winter	___	___	___	___	___
(3) No difference					
	(3/31)	(4/37)	(5/37)	(6/37)	(7/37)

b. What days and times are you disturbed most by (aircraft and/or "other source" noise)?

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
Days/times	___	___	___	___	___
No difference	___	___	___	___	___
	(3/32-33)	(4/38-39)	(5/38-39)	(6/38-39)	(7/38-39)

6

c. [*Use CARD E*]

How disturbed are you by (source) noise at this/these times?

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
Rating	(3/34-36)	(4/40-42)	(5/40-42)	(6/40-42)	(7/40-42)

6. [*For all major sources* noticed *(Q's 2a/2c)*]

Are there any activities which (source) noise interrupts?

[*Volunteered answers only*]

Source	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
Sleeping	___	___	___	___	___
Relaxing in	___	___	___	___	___
Relaxing out	___	___	___	___	___
Conversing in	___	___	___	___	___
Conversing out	___	___	___	___	___
Working in	___	___	___	___	___
Working out	___	___	___	___	___
T.V.	___	___	___	___	___
Telephone conversation	___	___	___	___	___
Eating	(3/37-46)	(4/43-52)	(5/43-52)	(6/43-52)	(7/43-52)

7. [*For all major sources* noticed *(Q's 2a/2c)*]

What effects on you and your family has (source) noise had?

[*Read list*]

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
Nervousness	___	___	___	___	___
Hearing loss	___	___	___	___	___
Irritability	___	___	___	___	___
Headaches	___	___	___	___	___
Interrupt sleep	___	___	___	___	___
Kept awake	(3/47-52)	(4/53-58)	(5/53-58)	(6/53-58)	(7/53-58)

8. [*For all major sources noticed (Q's 2a/2c)*]

Are there any effects of (source) noise that haven't been mentioned which concern you?

[*Write in as specified*]

AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
___	___	___	___	___
___	___	___	___	___
(3/53-54)	(4/59-60)	(5/59-60)	(6/59-60)	(7/59-60)

9. [*For each disturbing source only*]

When you are disturbed by (source) noise do you:

[*Read list*]

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
Close your window	___	___	___	___	___
Use air conditioning	___	___	___	___	___
Stay indoors	___	___	___	___	___
Turn on/up TV/radio/records	___	___	___	___	___
Wear earplugs	___	___	___	___	___
Contact noise source	___	___	___	___	___
Wait for noise to stop					
	(3/55-61)	(4/61-67)	(5/61-67)	(6/61-67)	(7/61-67)

10. [*For each disturbing source only*]

Have you ever taken any of these actions in response to (source) noise?

[*Read list*]

	AIRCRAFT	MAIN ROAD	TRUCKS	TRAINS	INDUSTRY
Written to newspaper	___	___	___	___	___
Contacted noise source	___	___	___	___	___
Contacted police	___	___	___	___	___
Contacted politician	___	___	___	___	___
Contacted other gov't official	___	___	___	___	___
Signed petition	___	___	___	___	___
Attended meeting	___	___	___	___	___
Joined protest group	___	___	___	___	___
Organized protest group	___	___	___	___	___
Other (specify)	___	___	___	___	___
	(3/62-71)	(4/68-77)	(5/68-77)	(6/68-77)	(7/68-77)
	AC	MR	TK	TN	IN

(79-80)

11. [*Ask only if* <u>*disturbed*</u> *by one or more major source*]

Which of the following actions have you considered to avoid unwanted noise? Have you taken any of them?

[*Read Categories*]

	Considered (1)	Taken (2)
Keep windows closed	___	___
Install air conditioning	___	___
Install extra insulation	___	___
Keep storm windows on	___	___
Install special glazing	___	___
Construct barrier (e.g. fence)	___	___
Plant trees	___	___
Other (specify)	___	___

(1/44-51)

12. [*If aircraft noise* <u>*not mentioned*</u> *(Q's 2a/2c)*]

[*Use CARD C*]

You haven't mentioned noticing the sound of aircraft. Because we are quite near to a flight path here, I'd like to know how you rate the sound of aircraft in this neighbourhood.

Rating (EA-ED)__________ (1/52)

13. [*ALL RESPONDENTS*]

a. Do you notice any effects from aircraft other than noise?

(2) yes _____

(1) no _____ (1/53)

b. What are they?

smoke/fumes _____
landing lights _____
T.V. interference _____
house vibration _____
other (specify) _____ (1/54-58)

9

14a. Do any other aspects of aircraft or airport operations concern you?

(2) yes ____

(1) no ____ (1/59)

b. What are they?

fear of crashes ____

other (specify) ____ (1/60-61)

c. How concerned are you by this?

[*Read categories*]

(1) slightly concerned ____
(2) moderately concerned ____
(3) considerably concerned ____
(4) extremely concerned ____ (1/62)

15a. Do you think sufficient is done to reduce the adverse effects of aircraft?

(1) yes ____ (3) don't know ____

(2) no ____ (1/63)

b. What do you think should be done?

____

____ (1/64)

____

16a. Overall, do you think the benefits of air transportation to society outweigh the disadvantages experienced by people living near airports.

(1) yes ____ (3) don't know ____

(2) no ____ (1/65)

b. To what extent do the disadvantages outweigh the benefits?

[*Read categories*]

(1) greatly ____
(2) considerably ____
(3) moderately ____
(4) slightly ____
(5) equal ____ (1/66)

10

And now a few questions about yourself.

17. [*DO NOT ASK*]

Sex (1) Male _____ (2) Female _____ (1/67)

18. What level of education have you completed?

(1) Some public school _____
(2) Public school graduation _____
(3) Some high school _____
(4) High school graduation _____
(5) Some university or college _____
(6) University or college graduation _____
(7) Post-graduate work _____ (1/68)

19. How old are you? _________ years (1/69-70)

20a. Do you have children living at home?

(2) yes _____
(1) no _____ (1/71)

b. What ages are they?

_______________ (1/72-74)

21a. What is your main occupation, (that is what sort of work do you do)?

____

b. What sort of business or industry do you work in?

_______________ (1/75-76)

c. Is that in anyway related to aircraft or airport operations?

(2) yes _____
(1) no _____ (1/77)

22a. What is the main occupation of the principal wage earner (that is what sort of work does he/she do)?

____

b. What sort of business or industry does he/she work in?

_______________ (1/78-79)

c. Is that in anyway related to aircraft or airport operations?

(2) yes _____
(1) no _____ (1/80)

23. If employed outside the home, how would you rate your place of work for noise?
[*Read Categories*]
(1) very quiet ____
(2) fairly quiet ____
(3) average ____
(4) fairly noisy ____
(5) very noisy ____
(6) not applicable ____ (2/10)

24. In general how sensitive are you to noise?
[*Read Categories*]
(1) not at all ____
(2) a little ____
(3) moderately ____
(4) considerably ____
(5) extremely ____ (2/11)

25. Please indicate which range most closely describes the income before taxes of this household in the past year?

[*Use CARD F*]

(1) Less than $5,000 ____
(2) $ 5,000 - $10,000 ____
(3) $10,000 - $15,000 ____
(4) $15,000 - $20,000 ____
(5) $20,000 - $25,000 ____
(6) $25,000 - $30,000 ____
(7) More than $30,000 ____
(8) don't know ____ (2/12)

26. How many hours do you normally spend at home each day?

	(1) less than 10	(2) 10-15	(3) 15-20	(4) more than 20
Weekdays	____	____	____	____
Weekends	____	____	____	____

(2/13-14)

27. In the summer, how many hours do you normally spend outside at home?

	(1) 0	(2) 1-2	(3) 3-5	(4) 6-10	(5) more than 10
Weekdays	____	____	____	____	____
Weekends	____	____	____	____	____

(2/15-16)

28. If noise levels were reduced, would your use of outdoor space increase?

(2) Yes ____
(1) No ____ (2/17)

12

29. Do you rent or own your residence?

(1) Rent ____

(2) Own ____ (2/18)

30. How long have you lived in this house/apartment? __________ (2/19-21)

31a. Have you ever considered moving to a quieter neighbourhood to avoid unwanted noise here?

(2) Yes ____

(1) No ____ (2/22)

b. How much longer do you expect to stay in this house/apartment?

__________ (2/23-25)

32a. On average how often do you or other members of the household travel by plane in a year?

(1) never ____
(2) less than once a year ____
(3) once or twice a year ____
(4) several times a year ____ (2/26)

b. On average how often do friends or relatives travel by plane to visit you in a year?

(1) never ____
(2) less than once a year ____
(3) once or twice a year ____
(4) several times a year ____ (2/27)

33a. Would you be willing to have a noise monitor on your property for a 24 hour period some time during the next month?

(2) yes ____

(1) no ____ (2/28)

b. Times when not convenient __________

____

c. Phone number __________

The following questions concern the type of dwelling you live in. Your help in filling them out is appreciated.

34. Building construction:

a. Number of stories in building ________ (2/29)

b. Building material:

(1) Brick ____
(2) Frame ____
(3) Stucco ____
(4) Asbestos panels ____
(5) Other (specify) ____ (2/30)

c. Type of windows:

(1) Single pane (openable) ____
(2) Thermal pane (not openable) ____
(3) Two panes (e.g. aluminum combination storms-openable) ____
(4) Double glazing (approx. 4" between panes; not openable) ____ (2/31)

d. Air conditioning:

(1) Central ____
(2) Window unit ____
(3) None ____
(4) Don't know ____ (2/32)

35. Type of dwelling unit:

(1) Apartment ____
(2) Flat ____
(3) Row/Townhouse ____
(4) Semi-detached ____
(5) Detached ____ (2/33)

36. If an apartment or flat, which floor? ________________ (2/34)

37. Date ________________ (day/month) (2/35-38)

38. FINISH TIME ____________ (2/39-42)

14

39a. Did aircraft noise interfere with interview?

(2)yes ____

(1)no ____ (2/43)

b. How often did it interfere?

(1) once ____

(2) two or three times ____

(3) several times ____

(4) almost continuously ____ (2/44)

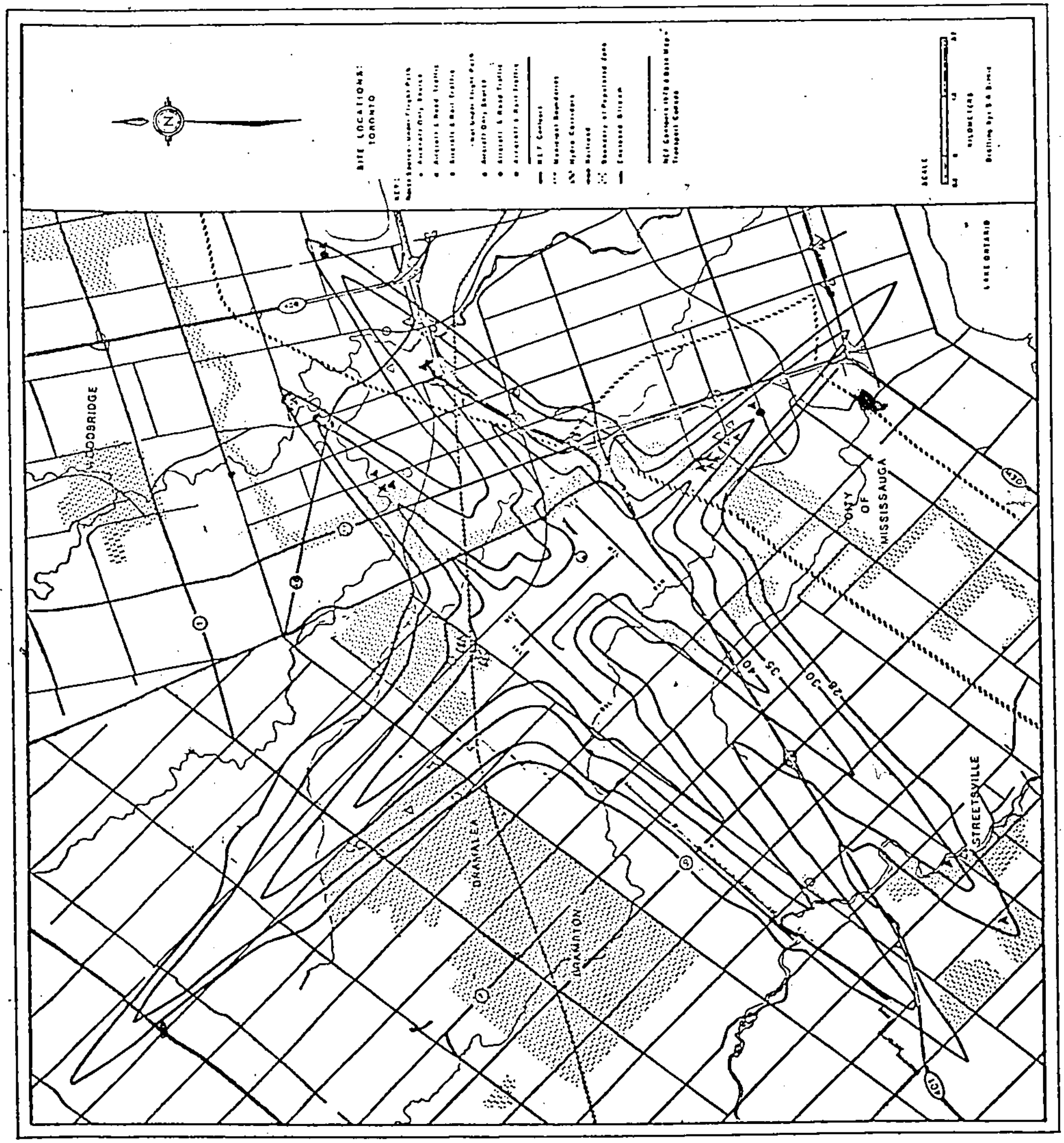
c. Where was interview conducted?

(1) indoors ____

(2) outdoors ____ (2/45)

APPENDIX 3

A Map Showing the Approximate Location of the 56 Sites at the Airport.



SITE LOCATIONS: TORONTO
WOODBRIDGE
CITY OF MISSISSAUGA
STREETSVILLE
BRAMALEA
BRAMPTON
LAKE ONTARIO
40
35
30
28

Poor Copy

APPENDIX 4

The Computer Output

RUNWAY UTILIZATION

RUNWAYS-		14L	32R	23R	05L	23L	05R	TOT
TAKEOFFS (ACTUAL)	D	9.4	53.0	49.1	9.2	33.3	10.4	164.4
	E	2.9	24.3	30.4	4.7	18.3	6.2	86.8
	N	2.2	8.9	5.1	2.1	7.5	.4	26.2
TAKEOFFS (PERCENT)	D	3.4	19.1	17.7	3.3	12.0	3.7	
	E	1.0	8.8	11.0	1.7	6.6	2.2	
	N	.8	3.2	1.8	.8	2.7	.1	
LANDINGS (ACTUAL)	D	28.4	23.1	19.7	17.7	33.0	25.4	147.3
	E	13.1	10.4	19.1	13.9	28.4	17.0	101.9
	N	10.3	1.1	2.6	3.0	3.7	8.5	29.2
LANDINGS (PERCENT)	D	10.2	8.3	7.1	6.4	11.9	9.1	
	E	4.7	3.7	6.9	5.0	10.2	6.1	
	N	3.7	.4	.9	1.1	1.3	3.1	

TOTAL TAKEOFFS 277.4 LANDINGS 278.4

TOTAL OPERATIONS - DAILY 556. - YEARLY 202871.
DEFAULT RUNWAY 2 32R

TOTAL FLIGHTS 320

00 0 0.000 TERMINATE DATA INPUT

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** .. HASHIM WAHBI

11/13/78.

A/C	A/C NAME		NC		ARRIVALS		0- 500		500-1000		1000-1500		1500-2500		2500-3500		3500-4500		4500- UP
1	2E NBTF	DC-9-32	2	D	49.1	48	44.8	49	5.6	49	2.4	49	.3	0	0.0	0	0.0	0	0.0
				E	31.6		23.7		2.2		1.4		0.0		0.0		0.0		0.0
				N	6.4		3.6		1.6		.3		0.0		0.0		0.0		0.0
2	3E NBTF	727-200	8	D	17.9	18	19.5	20	1.5	20	2.5	20	.2	0	0.0	0	0.0	0	0.0
				E	12.3		9.3		0.0		0.0		0.0		0.0		0.0		0.0
				N	4.7		2.0		0.0		.3		0.0		0.0		0.0		0.0
3		707-120B	11	D	17.7	38	7.1	39	2.9	40	2.4	41	3.4	42	.3	42	.4	42	0.0
				E	10.5		3.7		1.0		1.6		1.2		2.9		.5		0.0
				N	4.4		1.2		1.1		0.0		.3		1.5		.4		0.0
4	4E NTJ	707-120/320	19	D	1.7	21	.6	22	.4	23	.3	24	.4	25	.1	26	0.0	26	0.0
				E	1.1		.5		0.0		0.0		.3		.2		0.0		0.0
				N	.3		.1		.1		0.0		0.0		.1		0.0		0.0
5	3E MR WB	DC-10-10	14	D	10.1	12	4.3	13	1.2	14	2.1	15	2.8	16	0.0	16	0.0	16	0.0
				E	11.5		3.8		1.4		1.7		.9		1.7		.7		0.0
				N	2.3		1.2		.3		.3		.3		.4		0.0		0.0
6	4 ENG WB	747-200	16	D	4.3	6	.2	7	0.0	8	0.0	9	1.1	10	0.0	11	0.0	11	0.0
				E	4.9		1.0		0.0		0.0		1.3		4.4		0.0		0.0
				N	.6		0.0		0.0		0.0		.1		1.6		0.0		0.0
7	2ETFGA	SABRE LINER	21	D	11.5	86	14.6	86	0.0	86	0.0	0	0.0	0	0.0	0	0.0	0	0.0
				E	6.9		4.5		0.0		0.0		0.0		0.0		0.0		0.0
				N	1.6		.9		0.0		0.0		0.0		0.0		0.0		0.0
8	2ETP	TWIN OTTER	22	D	13.3	87	14.3	87	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
				E	8.4		7.0		0.0		0.0		0.0		0.0		0.0		0.0
				N	1.5		1.8		0.0		0.0		0.0		0.0		0.0		0.0
9	2EPGA	CESSNA 310	23	D	21.7	88	28.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
				E	14.7		9.9		0.0		0.0		0.0		0.0		0.0		0.0
				N	7.4		6.7		0.0		0.0		0.0		0.0		0.0		0.0

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF.	CNEL
-3, B	.1,.7	24 HOUR	153.5	44.3	10.9	.1	0.0	0.0	70.4	73.2	38.2	74.4
		EVENING	46.2	12.8	3.3	.0	0.0	0.0				
		NIGHT	13.3	4.8	1.1	.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-3135.00	1650.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-3, D	.3,**	24 HOUR	110.3	28.4	.2	0.0	0.0	0.0	64.1	66.3	30.5	67.6
		EVENING	33.5	8.2	.1	0.0	0.0	0.0				
		NIGHT	8.2	2.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-3300.00	3960.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-3, B	.5,.3	24 HOUR	159.1	46.1	12.4	.3	0.0	0.0	71.7	74.7	39.9	75.7
		EVENING	47.7	13.2	3.7	.1	0.0	0.0				
		NIGHT	13.7	5.2	1.3	.1	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-3465.00	1320.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-3, D	.6, .8	24 HOUR	110.6	29.0	.2	0.0	0.0	0.0	64.3	66.6	30.8	67.9
		EVENING	33.6	8.4	.1	0.0	0.0	0.0				
		NIGHT	8.2	2.4	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-3630.00	3795.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
-4, D	.1, .6	24 HOUR	108.6	28.5	.2	0.0	0.0	0.0	64.4	66.9	31.0	68.1
		EVENING	33.0	8.3	.1	0.0	0.0	0.0				
		NIGHT	8.2	2.5	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-4125.00	3630.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
-5, D	.8, .3	24 HOUR	118.0	28.5	.6	0.0	0.0	0.0	64.7	67.2	31.5	68.4
		EVENING	34.8	8.2	.1	0.0	0.0	0.0				
		NIGHT	10.5	2.5	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-5775.00	3300.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
-3, C	.3,.1	24 HOUR	137.4	36.2	9.1	.1	0.0	0.0	68.6	71.3	36.0	72.4
		EVENING	41.7	10.7	2.7	.0	0.0	0.0				
		NIGHT	12.1	3.4	.8	.0	0.0	0.0				

(TIME IN MINUTES ABOVE INDICATED DBA LEVEL: 65–115)

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-3300.00	2145.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
-17, -D	.8,.8	24 HOUR	100.1	20.6	.0	0.0	0.0	0.0	60.5	63.2	27.4	64.3
		EVENING	27.7	5.9	.0	0.0	0.0	0.0				
		NIGHT	11.2	1.7	.0	0.0	0.0	0.0				

(TIME IN MINUTES ABOVE INDICATED DBA LEVEL: 65–115)

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-17820.00	-3795.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-13, -F	.5,.9	24 HOUR	66.7	13.4	0.0	0.0	0.0	0.0	57.1	59.8	23.7	61.0
		EVENING	18.4	3.7	0.0	0.0	0.0	0.0				
		NIGHT	5.6	1.0	0.0	0.0	0.0	0.0				

(TIME IN MINUTES ABOVE INDICATED DBA LEVEL: 65–115)

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-13530.00	-5940.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-13, -C	.2,.5	24 HOUR	103.3	28.9	.5	0.0	0.0	0.0	64.0	67.1	31.8	68.2
		EVENING	28.4	8.2	.2	0.0	0.0	0.0				
		NIGHT	11.7	2.7	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-13200.00	-2475.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-12, -C	.7,.5	24 HOUR	104.0	29.0	.6	0.0	0.0	0.0	64.0	67.1	31.8	68.2
		EVENING	28.6	8.3	.2	0.0	0.0	0.0				
		NIGHT	11.8	2.7	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-12705.00	-2475.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NFF	CNFL
-4, I	.5,[illegible]	24 HOUR	67.8	.8	0.0	0.0	0.0	0.0	56.6	58.6	21.8	60.1
		EVENING	19.3	.5	0.0	0.0	0.0	0.0				
		NIGHT	4.5	.0	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-4455.00	8910.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
1, AA	.8,.1	24 HOUR	38.3	5.6	.3	0.0	0.0	0.0	58.8	60.1	25.4	62.4
		EVENING	14.7	2.9	.1	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1815.00	26070.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
0, Y	.0,.9	24 HOUR	36.8	5.3	.0	0.0	0.0	0.0	57.5	58.7	23.6	61.0
		EVENING	14.1	2.7	.0	0.0	0.0	0.0				
		NIGHT	1.4	.2	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
0.00	24915.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
1, T	.5,.8	24 HOUR	50.5	8.0	1.6	0.0	0.0	0.0	61.8	63.1	29.2	65.4
		EVENING	20.5	3.8	.8	0.0	0.0	0.0				
		NIGHT	1.7	.3	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1485.00	19800.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
1, S	.3,.6	24 HOUR	51.6	9.4	2.0	0.0	0.0	0.0	62.6	64.0	30.1	66.2
		EVENING	20.9	4.4	1.0	0.0	0.0	0.0				
		NIGHT	1.8	.3	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1320.00	18645.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
1, S	**,.3	24 HOUR	34.9	7.6	.6	0.0	0.0	0.0	60.2	61.6	27.1	63.8
		EVENING	13.8	3.6	.3	0.0	0.0	0.0				
		NIGHT	1.3	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1980.00	18315.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NFF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
3, S	.6,.1	24 HOUR	31.7	2.5	0.0	0.0	0.0	0.0	55.6	57.0	20.5	59.1
		EVENING	12.5	1.2	0.0	0.0	0.0	0.0				
		NIGHT	1.1	.1	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
3630.00	18150.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-23, -C	.4,.3	24 HOUR	105.7	24.4	.1	0.0	0.0	0.0	62.6	65.6	30.3	66.7
		EVENING	29.0	7.0	.0	0.0	0.0	0.0				
		NIGHT	12.1	2.5	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-23430.00	-2310.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-22, -C	.8,**	24 HOUR	103.2	20.6	.0	0.0	0.0	0.0	61.4	64.3	28.7	65.4
		EVENING	28.3	6.0	.0	0.0	0.0	0.0				
		NIGHT	11.7	1.8	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-22770.00	-2970.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
-21, -E	.9,.8	24 HOUR	80.8	16.3	0.0	0.0	0.0	0.0	58.4	61.1	25.1	62.2
		EVENING	22.5	4.5	0.0	0.0	0.0	0.0				
		NIGHT	8.1	1.3	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-21945.00	-4785.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
-18, -C	.3,.1	24 HOUR	111.8	29.2	.2	0.0	0.0	0.0	63.8	66.7	31.5	67.8
		EVENING	30.7	8.4	.1	0.0	0.0	0.0				
		NIGHT	12.6	3.1	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
-18305.00	-2145.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
26, -A	.6,.3	24 HOUR	37.4	10.5	2.3	0.0	0.0	0.0	63.2	63.8	29.7	65.7
		EVENING	10.7	3.1	.8	0.0	0.0	0.0				
		NIGHT	1.2	.3	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
26565.00	-330.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
26, B	.7,.2	24 HOUR	23.7	8.2	.4	0.0	0.0	0.0	58.9	60.0	25.7	61.7
		EVENING	6.5	2.4	.1	0.0	0.0	0.0				
		NIGHT	.7	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
26730.00	1155.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
29, A	.7,.2	24 HOUR	30.1	8.8	1.7	.0	0.0	0.0	62.3	62.9	28.6	64.8
		EVENING	8.6	2.7	.6	.0	0.0	0.0				
		NIGHT	.9	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
29700.00	165.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
29, A	.7,.8	24 HOUR	26.5	8.1	.5	0.0	0.0	0.0	59.9	60.7	26.2	62.5
		EVENING	7.5	2.5	.2	0.0	0.0	0.0				
		NIGHT	.8	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
29700.00	825.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
3,-HH	.1,.2	24 HOUR	120.0	21.8	.1	0.0	0.0	0.0	62.4	64.0	27.7	65.7
		EVENING	41.4	8.3	.0	0.0	0.0	0.0				
		NIGHT	7.1	.9	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
3135.00	-33165.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
12,-NN	.9,.9	24 HOUR	114.4	18.9	0.0	0.0	0.0	0.0	61.4	64.6	29.5	65.8
		EVENING	38.3	5.8	0.0	0.0	0.0	0.0				
		NIGHT	10.7	2.3	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
12870.00	-39930.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
14,-OO	.4,.3	24 HOUR	109.5	11.9	0.0	0.0	0.0	0.0	59.9	62.8	27.0	64.0
		EVENING	36.5	3.5	0.0	0.0	0.0	0.0				
		NIGHT	10.3	1.2	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
14355.00	-40260.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
12,-UU	.7,.9	24 HOUR	94.8	16.6	.0	0.0	0.0	0.0	60.9	63.6	28.4	65.0
		EVENING	32.3	6.1	0.0	0.0	0.0	0.0				
		NIGHT	8.7	1.4	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
12705.00	-46860.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
13, BB	.4,.6	24 HOUR	58.3	19.9	.2	0.0	0.0	0.0	62.1	63.7	28.1	65.5
		EVENING	23.1	7.9	.1	0.0	0.0	0.0				
		NIGHT	2.5	.9	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
13365.00	27555.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
12, LL	.7,.6	24 HOUR	57.9	18.7	.1	0.0	0.0	0.0	62.0	63.5	28.1	65.4
		EVENING	22.8	7.6	.0	0.0	0.0	0.0				
		NIGHT	2.6	.9	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
12705.00	37620.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
12, LL	.4,.1	24 HOUR	58.1	19.3	.1	0.0	0.0	0.0	62.5	64.1	28.8	66.0
		EVENING	22.9	7.8	.0	0.0	0.0	0.0				
		NIGHT	2.6	.9	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
12375.00	37125.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
22, -A	.6,.2	24 HOUR	53.4	16.0	2.8	.2	0.0	0.0	65.9	66.6	32.7	68.5
		EVENING	14.8	4.5	.9	.1	0.0	0.0				
		NIGHT	2.6	.5	.1	.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
22605.00	-165.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
22, A	.8,.7	24 HOUR	48.0	11.7	2.3	.0	0.0	0.0	62.9	63.8	29.9	65.6
		EVENING	13.2	3.2	.8	.0	0.0	0.0				
		NIGHT	2.2	.4	.1	.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
22770.00	660.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
23, -A	.1,.2	24 HOUR	47.2	15.3	2.7	.2	0.0	0.0	65.6	66.2	32.3	68.2
		EVENING	12.9	4.3	.9	.1	0.0	0.0				
		NIGHT	2.1	.5	.1	.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
23100.00	-165.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
23, A	.3,.7	24 HOUR	39.6	10.0	2.3	.0	0.0	0.0	62.7	63.6	29.7	65.5
		EVENING	11.3	2.9	.8	.0	0.0	0.0				
		NIGHT	1.6	.3	.1	.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
23260.00	660.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
23, -A	.6,.2	24 HOUR	43.9	15.3	2.7	.1	0.0	0.0	65.3	66.0	32.0	67.9
		EVENING	11.9	4.3	.9	.1	0.0	0.0				
		NIGHT	1.9	.5	.1	.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
23595.00	-165.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
25, B	.2,.2	24 HOUR	23.9	8.5	.4	0.0	0.0	0.0	59.2	60.4	26.2	62.1
		EVENING	6.6	2.4	.2	0.0	0.0	0.0				
		NIGHT	.7	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
25245.00	1155.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
25, A	.7,.3	24 HOUR	35.7	11.8	2.5	.0	0.0	0.0	63.5	64.2	30.1	66.1
		EVENING	10.1	3.5	.8	.0	0.0	0.0				
		NIGHT	1.2	.3	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
25740.00	330.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
1, AA	.7,.4	24 HOUR	38.2	5.7	.3	0.0	0.0	0.0	59.1	60.4	25.8	62.7
		EVENING	14.6	2.9	.2	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1650.00	26400.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
1, BB	.7,.1	24 HOUR	38.1	5.6	.3	0.0	0.0	0.0	59.0	60.3	25.6	62.5
		EVENING	14.6	2.9	.1	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1650.00	27060.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
1, BB	**,.2	24 HOUR	38.0	5.3	.1	0.0	0.0	0.0	58.2	59.4	24.4	61.7
		EVENING	14.5	2.7	.0	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1980.00	27225.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
0, DD	.5,.7	24 HOUR	36.9	5.2	.0	0.0	0.0	0.0	57.9	59.2	24.2	61.5
		EVENING	14.0	2.6	.0	0.0	0.0	0.0				
		NIGHT	1.5	.2	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
495.00	29700.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
0, EE	**,.0	24 HOUR	37.4	5.2	.2	0.0	0.0	0.0	58.6	59.9	25.1	62.1
		EVENING	14.1	2.7	.1	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
990.00	30030.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
0, EE	.7,.4	24 HOUR	37.0	5.2	.0	0.0	0.0	0.0	58.1	59.3	24.4	61.6
		EVENING	14.0	2.6	.0	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
660.00	30360.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
1, EE	.2,.5	24 HOUR	37.4	5.2	.2	0.0	0.0	0.0	58.5	59.8	25.0	62.1
		EVENING	14.1	2.6	.1	0.0	0.0	0.0				
		NIGHT	1.5	.2	.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
1155.00	30525.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
19, G	.3,.9	24 HOUR	38.1	2.3	0.0	0.0	0.0	0.0	56.1	58.6	22.2	59.9
		EVENING	10.4	.6	0.0	0.0	0.0	0.0				
		NIGHT	2.6	.1	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
19305.00	6930.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
16, J	.5,.7	24 HOUR	31.1	5.6	.0	0.0	0.0	0.0	59.1	61.2	24.6	62.5
		EVENING	9.7	1.8	0.0	0.0	0.0	0.0				
		NIGHT	1.9	.2	0.0	0.0	0.0	0.0				

X-START Y-START X-STEP Y-STEP NX NY OPTIONS
16500.00 9735.00 0. 0. 1 1 00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
17, H	.2,.2	24 HOUR	21.3	[illegible].6	.0	0.0	0.0	0.0	57.3	59.3	22.5	60.7
		EVENING	7.0	1.4	0.0	0.0	0.0	0.0				
		NIGHT	.9	.2	0.0	0.0	0.0	0.0				

X-START Y-START X-STEP Y-STEP NX NY OPTIONS
17160.00 12210.00 0. 0. 1 1 00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER- SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
15, Q	.7,.5	24 HOUR	44.6	5.6	0.0	0.0	0.0	0.0	58.0	59.5	22.8	61.1
		EVENING	17.8	1.8	0.0	0.0	0.0	0.0				
		NIGHT	1.8	.2	0.0	0.0	0.0	0.0				

X-START Y-START X-STEP Y-STEP NX NY OPTIONS
15675.00 16500.00 0. 0. 1 1 00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
12, W	.2,.6	24 HOUR	70.4	23.5	6.9	0.0	0.0	0.0	67.5	69.1	35.0	71.0
		EVENING	29.2	9.5	2.8	0.0	0.0	0.0				
		NIGHT	3.0	1.1	.3	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
12210.00	22605.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
11, CC	.4,.4	24 HOUR	58.6	21.0	1.3	0.0	0.0	0.0	64.4	66.0	31.2	67.9
		EVENING	23.1	8.4	.5	0.0	0.0	0.0				
		NIGHT	2.6	1.0	.1	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
11385.00	28380.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCHASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	65	75	85	95	105	115	LEQ	LDN	NEF	CNFL
			TIME IN MINUTES ABOVE INDICATED DBA LEVEL									
11, X	.9,.6	24 HOUR	59.3	23.5	6.3	0.0	0.0	0.0	67.2	68.9	34.7	70.8
		EVENING	24.0	9.5	2.5	0.0	0.0	0.0				
		NIGHT	2.5	1.1	.3	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
11880.00	23595.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
9, Z	.2,.6	24 HOUR	58.6	6.2	.0	0.0	0.0	0.0	58.6	60.0	23.6	61.8
		EVENING	22.7	2.0	0.0	0.0	0.0	0.0				
		NIGHT	2.5	.2	0.0	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
9240.00	25575.00	0.	0.	1	1	00000

FEDERAL AVIATION ADMINISTRATION INTEGRATED NOISE MODEL 1. 3
****MCMASTER TRANSPORTATION RESEARCH GROUP**** HASHIM WAHBI 11/13/78.

INTER-SECTION	OFF SET	PERIOD	TIME IN MINUTES ABOVE INDICATED DBA LEVEL 65	75	85	95	105	115	LEQ	LDN	NEF	CNEL
11, X	.4,.8	24 HOUR	58.7	22.2	3.0	0.0	0.0	0.0	65.8	67.4	32.9	69.3
		EVENING	23.8	8.9	1.2	0.0	0.0	0.0				
		NIGHT	2.5	1.0	.2	0.0	0.0	0.0				

X-START	Y-START	X-STEP	Y-STEP	NX	NY	OPTIONS
11385.00	23760.00	0.	0.	1	1	00000

REFERENCES

1. Stevens, K.N., Rosenblith, W.A., and Bolt, R.H., "A Community's Reaction to Noise : Can It Be Forecast?", Noise Control 1:63-71, 1955.

2. Cunniff, P.F., Environmental Noise Pollution. New York: John Wiley & Sons, 1977.

3. Cyril M. Harris, Handbook of Noise Control. New York: McGraw-Hill Book Company, Inc., 1957.

4. Arnold P.G. Peterson, and Erving E. Gross, Jr., Handbook of Noise Measurement, 6th Edition. West Concorde, Mass. : General Radio Company, 1967

5. K. D. Kryter and K.S. Pearsons, "Some Effect of Special Content and Duration on Percived Noise Level", Journal of the Acoustical Society of America, Vol.35, No.6, June 1963.

6. R.H. Lyon, Lectures in Transportation Noise. Cambridge, Mass. : Grozier Publishing, 1973.

7. U.S. Environmental Protection Agency, "Information of Levels of Environmental Noise Requisite to Protect Public Health and Welfare With Adequate Margin of Safety". Report 550/9-74-004, 1974.

8. Karl S. Pearsons, Ricarda L. Bennett, Handbook of Noise Ratings. Canoga Park, Calif. : Bolt, Beranek, Newman, Inc., April 1974.

9. S. Martin Taylor, Fred L. Hall and Susan E. Birnie. Community Response to Aircraft Noise in Relation to Background Noise Levels. Unpublished paper, 1979.

10. McMaster Research Group. "Community Response to Aircraft Noise in Southern Ontario; Some Preliminary Finding". Progress Report to Transport Canada, 1979.

11. K.D. Kryter, The Effect of Noise on Man. New York : Academic Press, 1970.

12. F.A.A. Office of Environmental Quality, January 1978. F.A.A. Integrated Noise Model Version 1, Basic User Guide, U.S. Department of Transportation.

13. Starkie, D.M., Johnson, D.M., The Economic Value of Peace and Quiet Lexington, Mass. : Saxon House, D.C. Heath Ltd., 1975.